NUCLEAR CRITICALITY SAFTEY PROGRAM (NCSP)

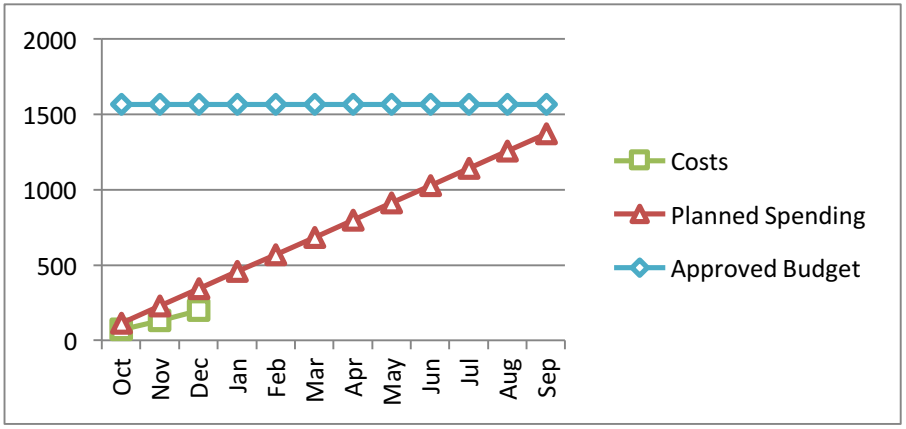
FY2018 1ST QUARTER REPORTS

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: AM1/AM2/AM4 (MCNP/NJOY/USL Comparison Study)
M&O Contractor Name: LANL
Point of Contact Name: Bob Margevicius / Bob Little
Point of Contact Phone: 505-665-8965 / 505-665-3487

Reference: B&R DP0902090
Date of Report: January 28, 2018

BUDGET



1. Carryover into FY-2018 = $0.
2. Approved FY-2018 Budget = $1,567,000 (Includes carryover from FY-2017).
3. Actual Spending through the end of this quarter in FY-2018 = $200,174.
4. Projected carryover into FY 2019 = $200,000.

ACCOMPLISHMENTS

MCNP

- **Education**
  - Off-site MCNP class at North Carolina State University.
  - Taught class at UNM, "Monte Carlo Techniques for Nuclear Systems", LA-UR-16-29043
  - Prepared lectures for advanced Monte Carlo class for UNM graduate students & LANL staff, "Advanced Computational Methods for Monte Carlo Calculations", LA-UR-18-20247
  - Acted as UNM sponsor for 2 LANL-NCS interns
  - Thesis advisor for 2 UNM graduate students working in area of criticality calculations

- **R&D Work**
  - Began effort to apply region-dependent sensitivity-uncertainty data to NCS validation
  - Using fission matrix methods to diagnose & accelerate MC source convergence
  - Investigating the impact of correlated fission multiplicity models CGMF and FREYA in criticality calculations
  - Collaborations with LANL groups NCS, C-AAC and NEN-2 on further studies into the validation for chlorine. Discussions include conducting binary measurements on solutions to develop a density law, arrangements for in situ measurements in PF-4, and designing integral experiments with chlorine.

- **Support & Maintenance**
  - ENDF/B-VIII-beta testing support
  - Code modernization effort - Efforts have begun to improve SQA, implement some MCNP-2020 features, & upgrade portions of MCNP6. Includes more formal planning, design proposals, improved code review, SQA tools, and more. (Most of funding is non-NCSP.)

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

	• **Professional society meetings**
	  o International Conference on Transport Theory, Monterey CA, October 2017
	  o ANS Winter meeting, Washington DC, October 2017
	
	• **Reports & Publications (available in MCNP Reference Collection on web)**
	  o F.B. Brown, "Advanced Computational Methods for Monte Carlo Calculations", LA-UR-18-20247 (2018)
	  o C.J. Werner, J.C. Armstrong, F.B. Brown, J.S. Bull, et al., "MCNP User's Manual - Code Version 6.2", LA-UR-17-29981 (2017)
	  o F.B. Brown, "Investigation of Clustering in Monte Carlo Criticality Calculations", International Conference on Transport Theory, Monterey CA, abstract LA-UR-17-27093, presentation LA-UR-17-29261 (2017)
	  o F.B. Brown, M.E. Rising, "Status Report on the MCNP 2020 Initiative", LA-UR-17-28985 (2017)
	  o C.R. Bates, J.A. Alwin, F.B. Brown, D.A. Dixon, H.G. Hughes, et al., Verification and Validation of MCNP6.2", IEEE Nuclear Science Symposium, Atlanta GA, LA-UR-17-29540 (2017)
	  o D.A. Brown, M.B. Chadwick, R. Capote, A.C. Kahler, A. Trkov, et al., "ENDF/B-VIII.0: The 8th Major Release of the Nuclear Reaction Data Library with CIELO-project Cross Sections, New Standards and Thermal Scattering Data", submitted to Nuclear Data Sheets, LA-UR-17-30870 (2017)
	
	• **Reports on summer intern work for NCSP (available in MCNP Reference Collection on web)**
	
	  ▪ **Publication & collection of these reports COMPLETES A MILESTONE FOR FY2018-Q1**
	
	  ▪ P.A. Grechanuk, "Semi-Analytic Benchmarks for MCNP6", presentation, LA-UR-16-28567, report LA-UR-16-28568, (2016)
	  ▪ P. Grechanuk, M.E. Rising, F.B. Brown, T.S. Palmer, "Semi-Analytical Benchmarks for MCNP6", Trans. Am. Nuc. Soc., Vol.116, p.709-711, paper LA-UR-17-20668, presentation LA-UR-17-24995 (2017)
	  ▪ P Grechanuk, M.E. Rising, T.S. Palmer, "Using Machine Learning Methods to Predict Bias in Nuclear Criticality Safety Simulations", International Conference on Transport Theory,

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

	Monterey CA, abstract LA-UR-17-27855, presentation LA-UR-17-29317 (2017) o P.A. Grechanuk, "Using Machine Learning to Predict MCNP Bias", LANL report, LA-UR-18-20175 (2018) • **ACE File Distribution** o We have a plan to distribute ACE files separately from MCNP. We have developed a website that we will announce when the ENDF/B-VIII.0 final libraries are available. It will be rather different from the way that data has been distributed in the past, but is sustainable for future needs. **NJOY** • NJOY support is going well. With the imminent release of ENDF/B-VIII.0 and the format changes that have been made very late in the game, we have spent a lot of time making the necessary changes to process the data. The latest version (NJOY2016.23) is available on GitHub and can process the latest versions of ENDF/B-VIII.0. • We continue to process ENDF/B-VIII.0 betas and run an extensive set of benchmarks on the processed data. • We participated in a Coordinated Research Project at the IAEA regarding producing ACE data files,

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

MILESTONES		ISSUES/PATH FORWARD
Provide status reports on LANL participation in US and International Analytical Methods collaborations (AM1, AM2: All Qtrs)		
Support MCNP6 users (AM1: All Qtrs)		
Support NJOY Users (AM2: All Qtrs)		
Provide reports on summer intern work accomplished (AM1: Q1)		
Develop a plan to distribute ACE files independent of MCNP releases (AM1: Q1)		
Issue an MCNP V&V report (AM1: Q2)		
Provide training course on theory and practice of Monte Carlo criticality calculations with MCNP6 (AM1: Q3)		
Release MCNP ACE data libraries corresponding to ENDF/B-VIII.0 (AM1: Q3)		
Develop Doppler broadening capabilities in NJOY21 (AM2:Q4)		
Issue report on the Sensitivity-Uncertainty Comparison Study (AM4: Q4)		
Develop a report for the NCSP manager on MCNP maintenance and modernization progress, the implementation of a parallel PTRAC capability, and the implementation of a Fission Matrix automated convergence checking capability (AM1: Q4)		
Issue a report on development and maintenance of the NJOY nuclear data processing code system (AM2:Q4)		

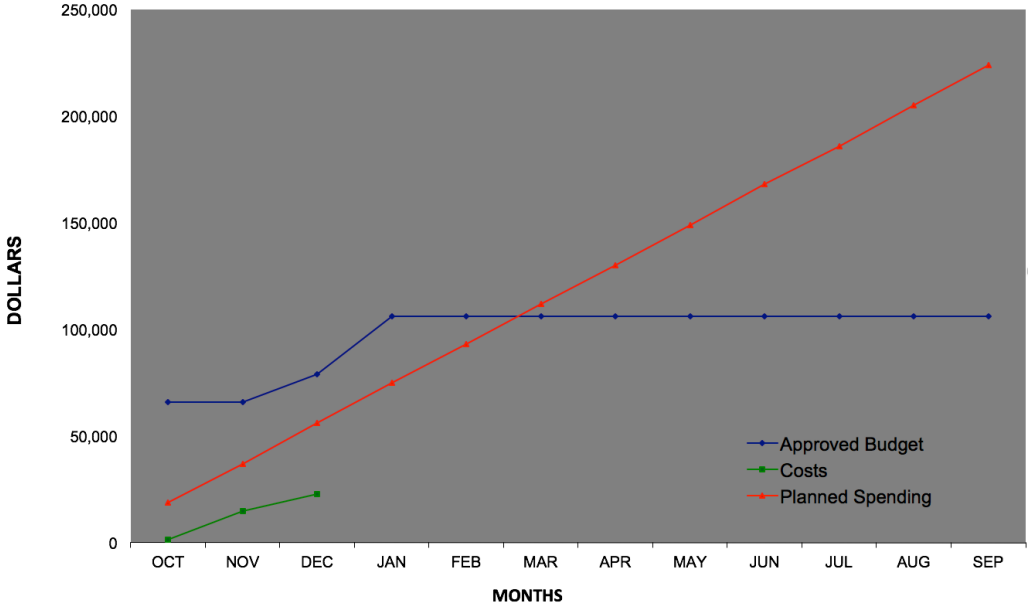
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY 2018 Q1)

NCSP Element and Subtasks: Analytical Methods,
LLNL Analytical Methods (AM1), Sliderule (AM3), Analytic Benchmarks (AM6)
M&O Contractor Name: Lawrence Livermore National Laboratory
Point of Contact Name: David Heinrichs
Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: January 26, 2018

BUDGET



1. Carryover into FY-2018 = $17,016
2. Approved FY-2018 Budget = $260,016 (Includes carryover from FY-2017)
3. Actual Spending through the end of this quarter (in FY-2018) = $22,984
4. Projected carryover into FY-2019 = $21,000 (8%)

ACCOMPLISHMENTS

LLNL Analytical Methods (AM1)

- Published LLNL-TR-743341, *A Comparative Study of the COG Thermal Libraries II*, including the latest thermal scattering law data from NCSU (LLNL ND2, ND3).
- Attended CSEWG and NDAG meetings at BNL on November 6-9, 2017 and presented LLNL-PRES-740584, *Integral Experiment Needs*.

Criticality Sliderule (AM3)

- Participated (with AWE, IRSN, ORNL) in a VTC on November 15, 2017 to finalize the specification for phase 3 of the project focusing on effects of:
  - Air moisture
  - Ground effects (i.e., soil, concrete)
  - Skyshine
  - Shielding (i.e., steel, lead, water, concrete)
- COG calculations for ground effects have been completed and calculations including air moisture are in progress.
- Designed and deployed https://ncsp.llnl.gov/am_criticality_sliderule.php to summarize the principle phases and major accomplishments of the project.

Analytic Benchmarks (AM6)

- LLNL and University Arizona convened a 'kick off' meeting at the 2017 ANS Winter Meeting in Washington, DC, to discuss scope and schedule.

MILESTONES FY2018

Provide status on LLNL AM activities in NCSP Quarterly Progress Reports (AM2, AM3 and AM6: All Qtrs).	
Provide an annual report on the LLNL multiphysics capability development (AM2).	

ISSUES/PATH FORWARD

- Approved budget reflects the actual funds received on October 13, 2017 December 22, 2017, and January 12, 2018.

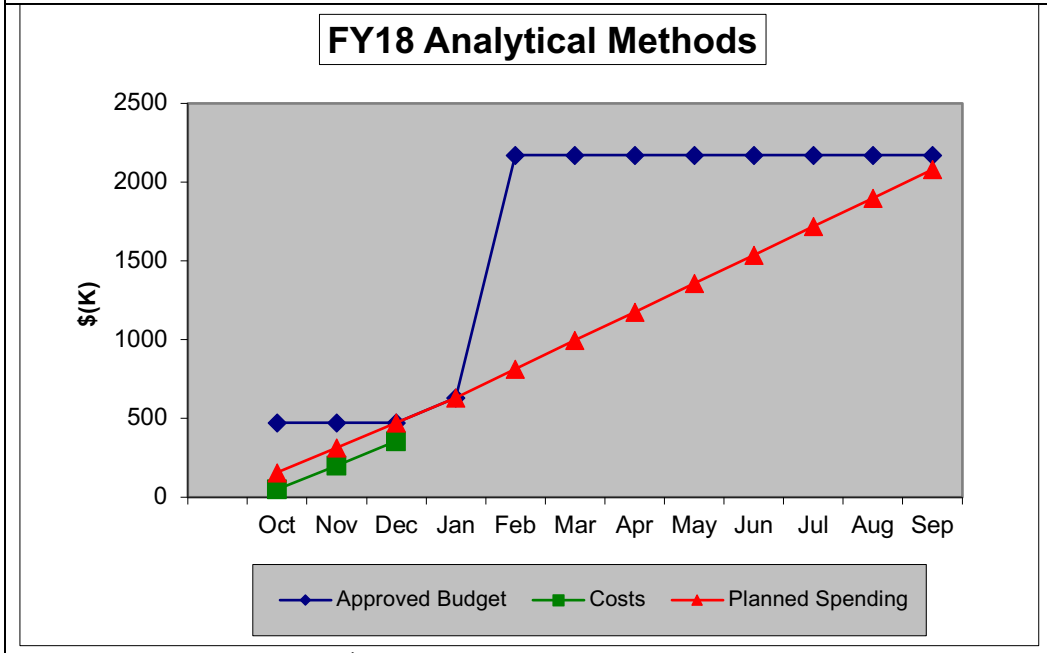
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: ORNL – AM1, 2, 3, 6, 9, 11, 13, 14
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0902000/ORNL
Date of Report: Jan 26, 2018

BUDGET



1. **Carryover into FY 2018** = $50K
2. **Approved FY 2018 Budget** = $2172K (includes carryover
3. **Actual spending for 1st Quarter FY 2018** = $357K
4. **Actual spending for 2nd Quarter FY 2018** = $0
5. **Actual spending for 3rd Quarter FY 2018** = $
6. **Actual spending for 4rd Quarter FY 2018** = $

ACCOMPLISHMENTS

AM1 – Distribution of available and newly packaged software

- Distributed 810 software packages and updated 1 software packages.
- 230 SCALE, 275 MCNP®, and 1 COG packages distributed.
- RSICC quarterly report issued.
- RSICC activities: See rsicc.ornl.gov<http://www-rsicc.ornl.gov/> for monthly newsletters.

AM2 - IRSN Area of Collaboration – SCALE/KENO/TSUNAMI

- **Status report on all ORNL participation in US and International analytical methods collaborations and travel.**
  - Planned Winter 2018 SCALE training courses at ORNL and OECD/NEA for February 2018.
  - Continued enhancements for SCALE 6.2.3 update to be released February 2018.
  - Answered 261 requests for user assistance through scalehelp@ornl.gov.
  - Since 2004, there have been over 13,280 distributions of SCALE to 8481 unique users in 58 nations.
  - Since April 2016, the distribution centers have issued licenses for 3,498 copies of the latest SCALE version.

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

<table>
<tr><td>NCSP Element and Subtask: ORNL – AM1, 2, 3, 6, 9, 11, 13, 14
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315</td><td>Reference: DP0902000/ORNL
Date of Report: Jan 24, 2018
Page 2 of 4</td></tr>
<tr><td></td><td>
AM3 - IRSN Area of Collaboration - AMPX
• Status report on all ORNL participation in US and International analytical methods collaborations and travel.
  ○ Participated in CSWEG meeting.
    ▪ Gave AMPX status report
    ▪ Status report about covariance testing of ENDF/B-VIII.0 beta data
    ▪ Status report about validation testing of ENDF/B-VIII.0 beta neutron cross section data testing
  ○ Processed ENDF/B-VIII.0 beta cross section data and covariance data to allow data testing on cross section and covariance data in preparation for release
  ○ Data testing on ENDF/B-VIII.0 beta data

AM6 – AWE and IRSN Area of Collaboration - SlideRule
• Status report on ORNL support
  ○ The entire team met in November via a video conference to review out FY17 work and plan our FY18 work.
  ○ Progress reports have been sent to the team in the fall 2017 to discuss progress on this task (Matthieu Duluc).

AM9 – IRSN Area of Collaboration - TSUNAMI
• Status report on ORNL support
  This task has not been initiated due to the continuing resolution and lack of funds to get started.
</td></tr>
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NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

<table>
<tr><td>NCSP Element and Subtask: AM1, 2, 3, 6, 9, 11, 13, 14
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315</td><td>Reference: DP0902000/ORNL
Date of Report: Jan 24, 2018
Page 3 of 4</td></tr>
<tr><td></td><td>AM11 – U. of Arizona and LLNL Area of Collaboration
This task has not been initiated due to the continuing resolution and lack of funds to get started.
AM13 – U of Florida Area of Collaboration
This task has not been initiated due to the continuing resolution and lack of funds to get started.
AM14 -U. of Tennessee Area of Collaboration
This task has not been initiated due to the continuing resolution and lack of funds to get started.</td></tr>
</table>

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: AM1, 2, 3, 6, 9, 11, 13, 14 **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315		**Reference: DP0902000/ORNL** **Date of Report: Jan 26, 2018** **Page 4 of 4**
MILESTONES	**Status**	**ISSUES/PATH FORWARD**
1. Provide status reports on all analytical method support activities in NCSP Quarterly Progress Reports (AM1, AM2, AM3, AM6, AM9, AM11: All Qtrs).		
2. Provide annual SCALE maintenance report (AM2: Q2).		
3. Publish annual newsletter (AM2: Q4)		
4. Document AMPX modernization and technical support (AM3: Q4)		
5. Complete annual IRSN-LLNL-ORNL status report (AM6: Q4)		
6. Complete summary report on TSUNAMI results (AM9: Q4)		
7. Status report of progress on acquiring and processing the latest beta and official releases of ENDF/B-VIII.0 with AMPX (AM13: Q1)		
8. Status report for running verification test cases and comparing results (AM13: Q3)		
9. Summary report for nuclear data and cross section testing using ENDF/B-VIII.0 (AM13: Q4)		
10. Status report on VALID progress (AM14: Q1)		
11. Status report running CE TSUNAMI-3D models (AM14: Q2)		
12. Status report for VALID and submit paper to winter ANS or NCSP professional conference (AM14: Q3)		
13. Status report on lessons learned, results and feedback for ORNL and final report for NCSP and ORNL (AM14: Q4)		

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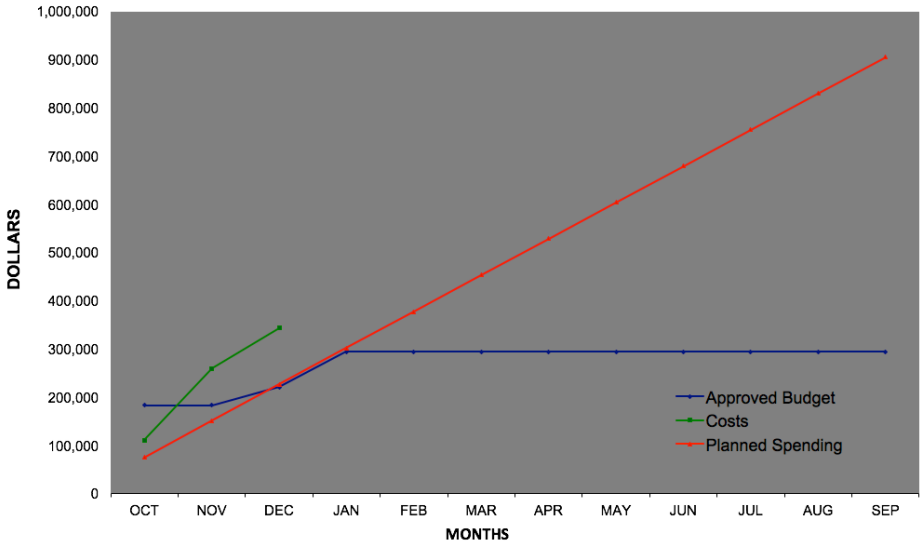
NCSP Quarterly Progress Report (FY 2018 Q1)

NCSP Element and Subtasks: Information Preservation & Dissemination, ICSBEP (IP&D1), Website and Red Net (IP&D2)
M&O Contractor Name: Lawrence Livermore National Laboratory
Point of Contact Name: David Heinrichs
Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: January 26, 2018

BUDGET



1. Carryover into FY-2018 = $0
2. Approved FY-2018 Budget = $984,000 (Includes carryover from FY-2017)
3. Actual Spending through the end of this quarter in FY-2018) = $343,415
4. Projected carryover into FY-2019 = $79,000 (8%)

ACCOMPLISHMENTS

ICSBEP Accomplishments (IP&D1)

- NCSP Manager hosted successful ICSBEP and IRPhE meetings at The George Washington University (GWU) in Washington, DC on October 23-27, 2017 with official "sponsorship" from the GWU Department of Physics.
- Eleven evaluations are in progress for publication in ICSBEP in FY-2018:
  - LANL: IER121 [Np SCR], IER151 [NCT#2], IER422 [SCRaP], IER423 [Flattop];
  - LLNL: IER203 [BeRP-CH2-Ni], IER406 [Cf-252], IER407 [ISSA];
  - SNL: IER206 [BUCCX], IER209 [7uPCXvH], IER230 [7uPCXvP], IER451 [BUCCX-Ti].

Website and Red Net Accomplishments (IP&D2)

- Completed website modernization design and deployed the website on https://ncsp.llnl.gov on October 26, 2017 in advance of the 2017 ANS Winter Meeting.
- Presented "DOE Nuclear Criticality Safety Program Website Modernization" at the ANS Winter Meeting in Washington, DC on October 31, 2017 including a "live" demonstration of the new design and its major features.
- Providing website updates as requested by NCSP Management.
- Archived and retained the legacy NCSP website at https://cedt.llnl.gov, which includes the IER/CEdT database that will be maintained until transfer to NNSA G2. This site can also be accessed by redirect from https://ncsp-beta.llnl.gov. Changed the C_EdT Manager from Doug Bowen to Thomas Miller granting him full access to the IER/CEdT database.
- Updated NTS-LAN/NCERC classified network images and servers; performed required monthly "authenticated" scans; submitted the NTS-LAN security plan for final review; and supporting the iSRD expansion to B600, U1a and NSF.
- Provided equipment inspections, certifications and data transfers in support of:
  - IER-299: KRUSTY
  - IER-474: OPSIS II
  - IER-490: NA-80 Science Measurements Nov 2017

MILESTONES FY2018

Manage all aspects of the DOE NCSP participation in the ICSBEP as required to ensure the finalizing and publishing ICSBEP evaluations per IE schedule (IPD1: All Qtrs).	
Provide status reports on LLNL participation in US and International IP&D collaborations (including ICSBEP) and provide brief trip summary report to NCSP Manager on items of NCSP interest (IPD1: All Qtrs).	
Maintain, operate and modernize the NCSP website, databases, and provide user assistance as required (IPD2: All Qtrs).	

ISSUES/PATH FORWARD

- Approved budget reflects actual funds received on October 13, 2017, December 22, 2017, and January 12, 2018.
- Planned spending is from the 5YP, Table 2.2-3.
- There is currently no schedule for LANL to:
  - Correct identified errors in the published Godiva-IV (TA-18) evaluation (HMF086);
  - Evaluate new Godiva-IV experiments performed in DAF;
  - Evaluate the Class Foils Moderated and Reflected by Lucite (IER-192).
  - Note: DNFSB staff have offered to assist at no cost to NCSP.
- Replaced NTS-LAN TACLANE at NSF due to device failure
- Working with Profile Unity vendor and LANL to resolve Kerberos NTS-LAN login issues

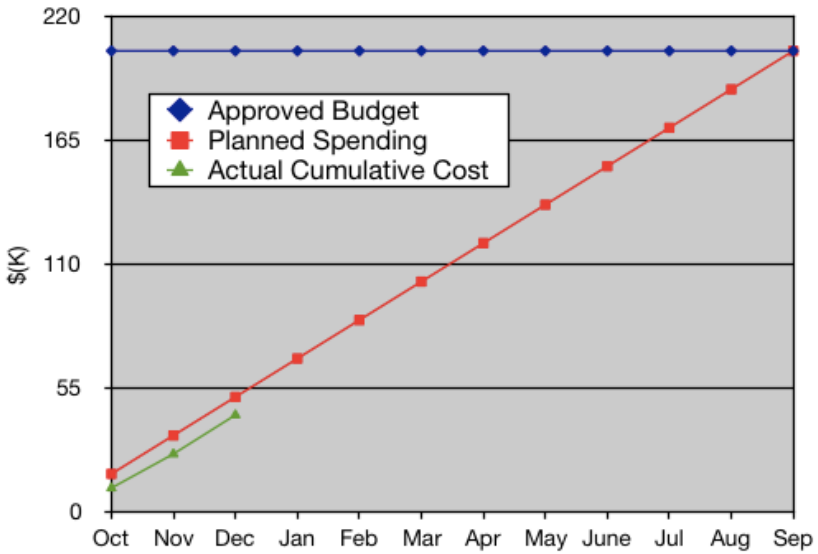
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: Nuclear Data BNL Task 1
M&O Contractor Name: BNL
Point of Contact Name: David Brown
Point of Contact Phone: 631-344-2814

Reference: B&R DP 0902090
Date of Report: Jan 25, 2018

BUDGET



1. Carryover into FY-2018 = $15,478
2. Approved FY-2018 Budget = $204,912 (Includes carryover from FY-2017)
3. Actual Spending through the end of this quarter in FY-2018 = $43,220

ACCOMPLISHMENTS

- ENDF/B-VIII.0 β6 released 15 Dec 2018
  - Decision to use "Trial B" light H_2O TSL file, resolving poor elevated temperature behavior in certain systems
  - Decision to use 30% "cubic approximation" reactor graphite and crystalline "cubic approximation" graphite
  - Add P(nu) data to ^{235,238}U
  - Add covariance data to several isotopes
  - Many small fixes
  - Fix factor of 2π in several charged particle elastic cross sections (d+^{7}Li, α+α, ^{3}He+^{3}He, ^{3}He+α, p+α, t+α)
- ENDF/B-VIII.0 β7 released 16 Jan 2018
  - "Release candidate"
  - Add 10% "cubic approximation" reactor graphite
  - Many small fixes
- Publication of D.A. Brown, *et al.,* "ENDF/B-VIII.0: The 8th Major Release of the Nuclear Reaction Data Library with CIELO-project Cross Sections, New Standards and Thermal Scattering Data," Nuclear Data Sheets **148**, 1 (2018).

MILESTONES

Maintain and upgrade ADVANCE code system by performing data verification of new NCSP evaluations and performing quality assurance on the data as required and provide status reports on all nuclear data support activities to the NCSP Manager (Q1, Q2, Q3, Q4)	
If mandated by CSEWG, release new ENDF library (Q3)	

ISSUES/PATH FORWARD

- ENDF/B-VIII.0 to be released on Feb. 2, 2018, approximately the 50th anniversary of the first ENDF release (1st release was June 1968!)
- Graphite changes in β6 & β7 necessitate a report/article describing changes and their testing.

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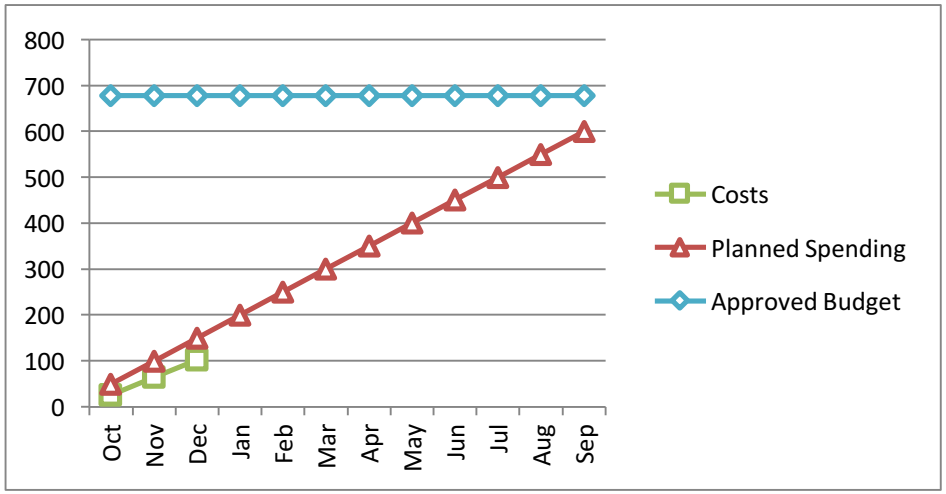
NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: ND1 (Nuclear Data Evaluation and Testing)
M&O Contractor Name: LANL
Point of Contact Name: Bob Margevicius / Bob Little
Point of Contact Phone: 505-665-8965 / 505-665-3487

Reference: B&R DP0902090
Date of Report: January 28, 2018

BUDGET



1. Carryover into FY-2018 = $0.
2. Approved FY-2018 Budget = $678,000 (Includes carryover from FY-2017).
3. Actual Spending through the end of this quarter in FY-2018 = $102,536.
4. Projected carryover into FY 2019 = $78,000.

ACCOMPLISHMENTS

- Participated in the 2017 CSEWG evaluation session. In the absence of Chadwick, Talou chaired the post-ENDF/B-VIII session.

- Initial efforts and discussions on the use of machine learning (ML) algorithms for nuclear data evaluations have started among many T and XCP members. Amy Lovell (U. Michigan) will be applying for a joint T2-CNLS postdoc appointment (w/ Talou and Chertkov) to work on ML techniques to optimize model parameters entering in the consistent calculation of prompt fission neutron and gamma data (spectrum, multiplicity, distributions, correlations).

- Talou visited LLNL and discussed with Snyder and Bowden about fission TPC progress and results. LANL will host a 1-day discussion in Feb-March on the topic between experimentalists, theorists, and evaluators, which will hopefully lead to a better use of the fission TPC data in the evaluation process. We also continue discussions with the chi-nu experimental team to finalize the Pu239 PFNS with high-energy data.

- For the light nuclei, LANL contributed a number of evaluations for the latest release of ENDF/B-VIII.0. They include: n-n scattering to 50 MeV, n-p scattering (a standard) and capture to 20 MeV, n+6Li (standard) to 20 MeV, n+9Be (angular distributions), n+10B (standard) to 20 MeV, n+12C to 150 MeV, n+13C to 20 MeV, and n+16O to 150 MeV. Note that n+C(nat) is also a standard below 1.8 MeV. We provided covariances for almost all these evaluations over the energy ranges specified.

MILESTONES		ISSUES/PATH FORWARD
Provide status reports on LANL participation in US and International Nuclear Data collaborations (ND1; All Qtrs)		
Conduct CSEWG Data Evaluation Committee session (ND1: Q1)		
Report data testing results with ENDF/B-VIII.0 cross sections (ND1: Q1)		
Report planning status of LANL initiative focused on machine learning for nuclear data (ND2: Q4)		
Deliver nuclear data evaluations as indicated in Appendix B of this document (ND1: Q4)		

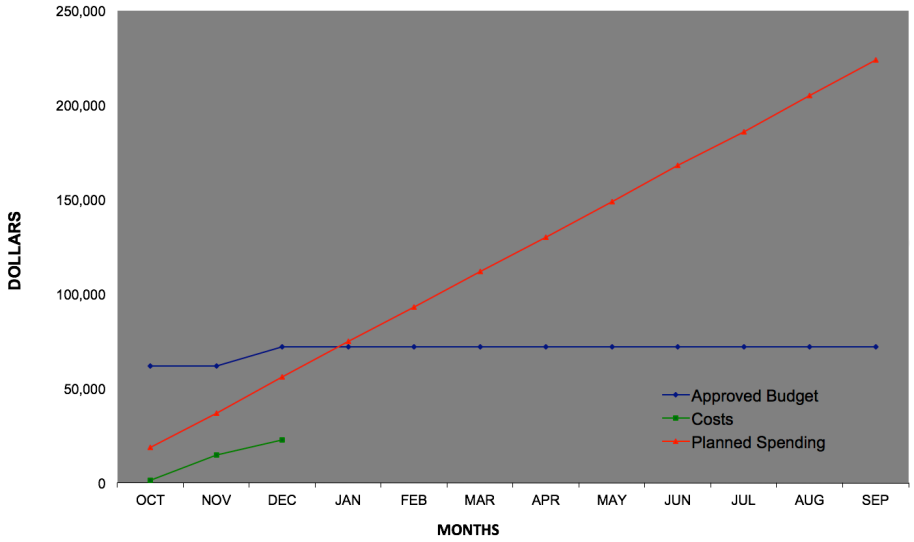
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY 2018 Q1)

NCSP Element and Subtask: Nuclear Data
DFGs (ND1), TSLs (ND2), Codes (ND3), Doppler (ND5), Cadmium (ND6)
M&O Contractor Name: Lawrence Livermore National Laboratory
Point of Contact Name: David Heinrichs
Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: January 26, 2018

BUDGET



1. Carryover into FY-2018 = $55,705
2. Approved FY-2018 Budget = $463,705 (Includes carryover from FY-2017)
3. Actual Spending through the end of this quarter (in FY-2018) = $30,730
4. Projected carryover into FY-2019 = $88,705 (19%)

ACCOMPLISHMENTS

Delayed Fission Gammas (ND1)

- LLNL and IRSN are comparing DFG multiplicity and spectra calculated by COG and ORIGEN at 5 and 50 minutes after a solution excursion.

Thermal Scattering Laws (ND2)

- NCSU initiated work on MD models for light water. The TIP4P/2005f force field was used within the LAMMPS code to perform the simulations. The current models successfully reproduce key properties of water including density and diffusivity (of the water molecule) at 298 K and 1 atm.
- NCSU performed extensive benchmark testing of the graphite TSL showing the ENDF/B-VIII.beta6 cubic libraries predict criticality better than the ENDF/B-VII.1 library and are therefore accepted for inclusion in ENDF/B-VIII.0.
- NCSU presented *Evaluation of the Thermal Neutron Scattering Law for a Heavy Paraffinic Molecular Material* on November 1, 2017 at the ANS Winter Meeting. NCSU A paper was submitted to the PHYSOR 2018 meeting giving the details of this work.
- NCSU reviewed and edited the upcoming ENDF/B-VIII.0 'big paper'.

Next Generation Codes (ND3)

- NCSU continued work on the *FLASSH* code to improve algorithms and execution capabilities. A new algorithm that separates the coherent bound and incoherent bound cross section was implemented. The *FLASSH* GUI was modified to check input errors and issue the needed warnings. Additionally, consistency of input was assured by limiting input options according to the model choices selected by the user.

Advanced Doppler Broadening (ND5)

- NCSU initiated examination of the currently existing methods for Doppler broadening in the NJOY and SAMMY codes. The source files for these codes are currently being analyzed to determine the approach for upcoming modifications.

Radiative Capture Gamma Production in Cadmium (ND6)

- Presented LLNL-PRES-740584, "Integral Experiment Needs," at the 27th NDAG meeting on November 9, 2017 at BNL, showing discrepancies for Cd radiative capture gamma lines in EGAF, CapGam, and JEFF3.2 libraries.

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY 2018 Q1)

NCSP Element and Subtask: Nuclear Data DFGs (ND1), TSLs (ND2), Codes (ND3), Doppler (ND5), Cadmium (ND6) M&O Contractor Name: Lawrence Livermore National Laboratory Point of Contact Name: David Heinrichs Point of Contact Phone: (925) 424-5679		Reference: B&R DP0909010 Date of Report: January 26, 2018 Page 2 of 2
MILESTONES FY2018		**ISSUES/PATH FORWARD**
Provide status on LLNL ND activities in NCSP Quarterly Progress Reports (ND1, ND2, ND3, ND5, ND6: All Qtrs)		• Approved budget reflects actual funds received on October 23, 2017, December 22, 2017, and January 12, 2018. • Planned spending reflects the 5YP, Table 2.4-7. • The thermal scattering data evaluations listed in Accomplishments were completed well in advance of the Appendix B schedule.
Provide status on LLNL/NCSU nuclear data activities to NCSP Manager (ND2, ND3, ND5: All Qtrs)		
Provide status on LLNL/IRSN nuclear data activities to NCSP Manager (ND1: All Qtrs)		
Deliver thermal neutron scattering data evaluations as indicated in Appendix B of the 5-Year Plan (ND2: Q4)		

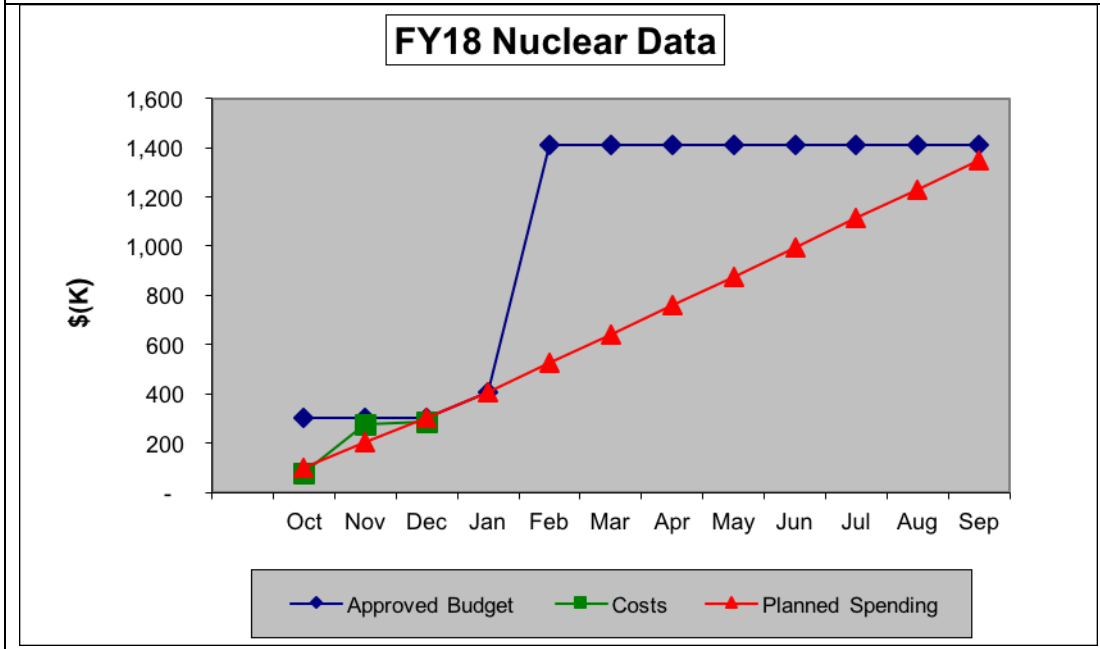
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: ORNL – ND1, 6, 7, 8
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0902000/ORNL
Date of Report: January 27, 2018

BUDGET



1. **Carryover into FY 2018** = $41K
2. **Approved FY 2018 Budget** = $1,408K (includes carryover)
3. **Actual spending for 1st Quarter FY 2018** = $287K
4. **Actual spending for 2nd Quarter FY 2018** = $0
5. **Actual spending for 3rd Quarter FY 2018** = $0
6. **Actual spending for 4rd Quarter FY 2018** = $0

ACCOMPLISHMENTS

ND1 – Evaluations and Measurements

- **Status report on all nuclear data support activities.**
  - Participation in the CSEWG meeting in November. Presentation of ORNL nuclear data measurements for the NCSP.
  - Presentation at the special NCSP session of the ANS winter meeting.
  - Evaluation work continues in the resolved resonance region for the isotopes of Gadolinium in support of ORNL-ND1 work task. Analysis and improvement of the fit of a number of experimental data sets in the resolved resonance region continues to be improved to achieve a lower chi-squared metric of fitting. Preliminary benchmarking work has started for the isotopes of gadolinium based on relevant ICSBEP benchmarks. Initial applications of the, NCSP developed code, SAMINT, shows potential to decipher the correct fitting of the experimental data in the thermal energy region by systematically incorporating integral benchmarks into the evaluation process.
  - Moderate improvement of the fit of experimental data has been achieved in Q1 of FY2018 for the resonance evaluation of cerium. Future acceleration of the evaluation process is expected once experimental data for an isotopically-enriched sample of Ce-142 becomes available.
  - Work on the set of Dysprosium evaluations. Analysis of experimental data, external functions and simultaneous fit of all experimental data. Initial work to define the unresolved resonance region parameterization
  - Work on the ^{239}Pu covariance file for ENDF/B-VIII.0 library in collaboration with LANL
  - Work on articles on ^{235}U, tungsten evaluations and ^{40}Ca related to the ORNL evaluation work released within the ENDF/B-VIII.0

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: ORNL – ND1, 6, 7, 8 **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2018
BUDGET	**ACCOMPLISHMENTS**
	• **Status report on all ORNL participation in US and International nuclear data collaborations and foreign travel.** o Travel in October to JRC-Geel Belgium. o Collaboration efforts on the resonance evaluation of gadolinium are continuing between ORNL (Gd-156, Gd-158, Gd-160) and IRSN (Gd-155, Gd-157). Periodic collaboration visits are resulting in improved fitting of differential experimental data and better performance in integral benchmarks though the synchronization of resonance parameters. As each lab, ORNL and IRSN, independently improves the resonance parameters for the respective isotopes, both gain from the exchange of information. Further new ideas are developed in the collaboration for evaluation in the unresolved resonance region where the current gadolinium evaluation has been shown to be discrepant with experimental measurements. o Initial discussions about the upcoming evaluation of the angular distributions for the isotopes of lead have begun. The opinion is that the resonance parameters will needs to be systematically updated to allow for a consistent fitting of the angle integrated cross sections and the angular distribution of scattering. Work on the evaluation of lead is scheduled to begin in Q3 of FY18 in accordance with the Appendix B of the NCSP 5 Year Plan. o The Nov-2017 trip to participate in the Fall-WPEC meeting has been competed in accordance with Appendix C and a foreign trip report has been provided to the NCSP manager. Sobes leads the WPEC-SG44 devoted to improving covariance data and also contributes to SG-39 (continuing as SG-46) on uses of integral experiments in nuclear data as well as SG-43 and EG-GNDS on the development of the modern nuclear data format and SG-45 on the creation of a validated input library for integral benchmark experiments.

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: ORNL – ND1, 6, 7, 8 **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2018
BUDGET	**ACCOMPLISHMENTS**
	○ Travel to the Nuclear Data Week in November 2017 ○ Work on two presentations. The first one related to the evaluation work (Resolution ID 105051) and the second related to definition of nubar fluctuations and the coupling between resolved resonance region and nubar (Resolution ID 105086) • **Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B of the 5-year plan.** ○ Travel in October to Geel Belgium to perform cross section experiments ○ Initiated cross section experiments for La. ○ Data sorting of the previously obtained neutron capture data for a thick Ce sample. This experiment was needed to get better statistics at higher neutron energies. Due to a closed neutron shell the neutron capture cross section of Ce-140 is very small. ○ The resonance evaluation for the isotopes of gadolinium (jointly between ORNL and IRSN) is expected to be delivered by the end of Q2 FY19 in accordance with Appendix B. The completion of the resonance region evaluation of the isotopes of Cerium is dependent of the availability of the experimental data for isotopically-enriched Ce-142. The work on the angular distribution of lead is on track to begin in Q3 of FY18.

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: ORNL – ND1, 6, 7, 8 **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2018
	ACCOMPLISHMENTS
	ND6 – SAMMY Modernization • **Status report on all SAMMY modernization progress** o A list of desired SAMMY features slated for the next incremental release of the SAMMY has been established in discussions with SAMMY users. Some of the key new features include: 1. Modernize SAMMY Coulomb functions by interfacing to a modern implementation published by N. Michel, Comp. Phys. Comm. 176 (2007) 232-249. 2. Extend the channel summation in SAMMY to include closed channels, and make corresponding modification to computation of analytical derivatives. 3. Implement transform between formal and alternative R-matrix parameters published by C.R. Brune, Phys. Rev. C 66 (2002) 044611. o Feature 1. is near completion in testing and validation phase, to be followed shortly by implementation of Feature 2. • **SAMMY modernization progress report (Q4)** o Work not yet started. **ND7 – Collaboration task with GA Tech** • Work not initiated. Funds not sufficient to start contract development to start the work. **ND8 – Nuclear Data Work Plan for U-233 for the NCSP (Due Q3)** • **Status report** o Discussion at the NDAG meeting in November about the U-233 justification and needs. Evaluation of the nuclear data situation for U-233 and assessment of the U-233 ENDF/B-VII evaluation.

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: ORNL – ND1, 6, 7, 8 **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315		**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2018
MILESTONES	**Status**	**ISSUES/PATH FORWARD**
1. Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (ND1, ND6, ND7: All Qtrs).		
2. Provide status reports on ORNL participation in US and International Nuclear Data collaborations, and for foreign travel, provide brief trip summary report to NCSP Manager on items of NCSP interest (ND1: All Qtrs).		
3. Complete cross-section measurement and evaluation deliverables per the nuclear data schedule in Appendix B (ND1: All Qtrs).		Enriched Zr and Ce-142 experiments delayed ue to problems obtaining samples for lease. The completion of the resonance region evaluation of the isotopes of Cerium is dependent of the availability of the experimental data for isotopically-enriched Ce-142.
4. Complete nuclear data work plan for ^{233}U and provide plan to NCSP Manager (ND8: Q3)		
5. Document SAMMY modernization progress and report status annually to the NCSP Manager (ND6:Q4)		

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

ORNL/LTR-2017/536

Reactor and Nuclear Systems Division

LETTER REPORT

NCSP ORNL NUCLEAR DATA SUBTASK 6 (ND6): SAMMY MODERNIZATION

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1. INTRODUCTION

SAMMY [1] is an Oak Ridge National Laboratory (ORNL) legacy code used worldwide to evaluate nuclear differential reactions cross section data in resolved and unresolved resonance energy ranges induced by incoming neutrons, protons, and α-particles. SAMMY updates phenomenological non-relativistic *R*-matrix resonance parameters via the Newton-Raphson iterative minimization of generalized χ^2-function to yield optimal posterior resonance parameter values, their covariance matrix, and the corresponding evaluated nuclear data and covariance matrix. SAMMY accounts for various experimental effects that are custom tailored to several leading measurement facilities and detectors. Over several decades, SAMMY has become established as an important tool for nuclear data resonance parameter evaluations disseminated via the US Evaluated Nuclear Data File (ENDF) for simulations of nuclear systems by neutron transport code systems such as SCALE [2].

To ensure SAMMY's status as an essential tool for evaluating anticipated, new kinds of higher precision data and for evaluating larger volumes of data while leveraging increasing, evolving resources of high-performance computing platforms, the Department of Energy's Nuclear Criticality Safety Program (NCSP) has proactively allocated funding for SAMMY modernization (ORNL Nuclear Data Subtask 6) at a level of ~1 full-time equivalent (FTE)/year for each year in its FY 2017–2022 plan.

To implement a modernization project of this magnitude, and in view of SAMMY's vast feature set implemented entirely in old-fashioned serial FORTRAN 77, the overarching goals of the SAMMY modernization project are to improve maintainability, modularity, feature extensibility, and computer performance by using modern, object-oriented development, quality assurance, and high-performance computing frameworks. This goal was pursued in the following coordinated tasks/activities to ensure smooth transition from the legacy SAMMY to a completely modernized SAMMY:

1. Port the legacy SAMMY 8.0.0 into modern software quality assurance (SQA) framework by modernizing and automating its build and test system; accomplish this by leveraging the SQA system already adopted by ORNL's SCALE [2] and AMPX [3] code systems. This was officially completed, and made available to the public with the release 8.1.0 of SAMMY via ORNL's Radiation Safety Information Computational Center (RSICC) in April of 2017.
2. Use the SQA platform established in step 1 as the foundation for making incremental changes to the legacy SAMMY code while supporting ongoing nuclear data evaluations at ORNL and elsewhere. When possible, use application programming interface (API)-based programming to enable comparisons between the results of the legacy system and the modernized implementations of an API to divide SAMMY modernization into tractable tasks.
3. In parallel with step 2, design and implement various APIs for C++ modernized SAMMY modules to be developed entirely within this modern SQA framework, thus enabling source code sharing with SCALE and AMPX code systems, which already employ the API programming model.
4. Generalize and modernize mathematical and physical methods implemented in the legacy SAMMY 8.0.0 code, and implement them strategically during modernization.
5. Anticipate future features and applications of modernized SAMMY to ensure that they could be accommodated into the software framework of the modernized SAMMY.

In the initial phase, a survey was performed of various programing frameworks, computer languages, and third-party libraries that could be efficiently used to transform SAMMY into a transparent, feature-extensible, high-performance parallelized software. Several theoretical and numerical improvements of the R-matrix formalism have been considered for the resolved resonance energy range. Beyond this energy range, we have been actively looking for ways to extend the SAMMY domain into the thermal (i.e., low-) and high-energy ranges that presently define energy limits of applicability of the R-matrix from below and above, respectively. Based on the options surveyed, it was concluded that, just

like SCALE and AMPX, the modernized SAMMY should be written in C++ API framework using third-party high-performance libraries when optimal.

To minimize complicated interdependencies among various modules of the legacy SAMMY code, the Bayesian fitting procedure and the computation of the R-matrix cross sections will be separated into implementations of their corresponding APIs in modernized SAMMY. This separation by the API will simplify the code's structure, and it will also make a standalone Bayesian nonlinear fitting capability accessible to other parts of SCALE and AMPX. This will be accomplished via the Fit API that was designed and implemented in the modernization process. To ensure backward compatibility of the modernized SAMMY, the initial implementation of the Fit API is the generalized least squares Newton-Raphson method that was already implemented in the legacy SAMMY. Although the Monte Carlo implementation of the Fit API is absent in the legacy SAMMY, it should be implemented in the modernized SAMMY to include the advantages of Monte Carlo optimization methods.

Since the R-matrix formalism of reactions can be expressed entirely in terms of matrix operations, transparent interfaces to high-performance linear algebra third-party libraries have been identified to enable efficient, high-level programming. These interfaces would also scale to the growing resources of high-performance computing platforms. In particular, a high-level *cpp-array* [10] interface was chosen to use with any third-party implementation of the Basic Linear Algebra Subprograms (BLAS). This interface was selected while implementing the generalized least squares version of the Fit API mentioned in the previous paragraph.

Once modernization is complete, it will be much easier to implement the desired SAMMY features. These features include the capability to optimize resonance parameters of more than one nuclide to many different cross section data simultaneously. It would also allow for SAMMY code to be shared seamlessly inside the SCALE and AMPX API-based framework. Simultaneous evaluations of differential cross section data and integral benchmark experiment data is one of several planned features discussed in Section 7 that could be accomplished in the modernized SAMMY framework.

2. SOFTWARE DESIGN PRINCIPLES FOR MODERNIZED SAMMY

Considerations of code reusability, feature extensibility, and the maintainability requirements of modernized SAMMY can be summarized in a high-level API-based layout of a modernized SAMMY (code named SAMSON), as shown in Fig. 1.

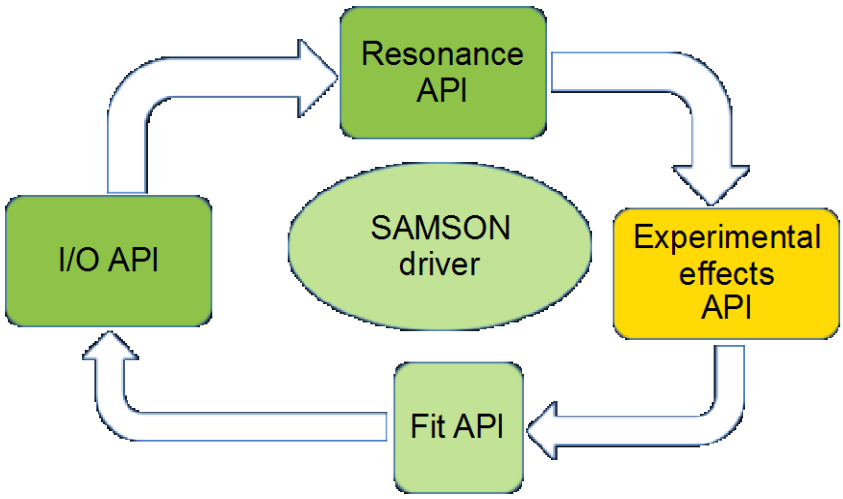


Fig. 1. High-level API-based modular design of modernized SAMMY enables interfacing to C++ AMPX implementations of Resonance API and I/O API for efficient code sharing among AMPX and SCALE modules.

Table 1 briefly describes the current implementation status of the APIs identified in Fig.1.

Table 1. Description and implementation status of the four main APIs of modernized SAMMY

API name	Description	Implementation status	features
Resonance	Computes R-matrix cross sections	Shared with AMPX	Supports all ENDF formats
I/O	Reads/writes from/to various input/output file formats	ENDF I/O imported from AMPX; SAMMY I/O implementation in progress	A backward-compatible replacement of I/O in modernized SAMMY
Fit	Generic optimization of model parameters to measured data	Generalized Least Squares method implemented, Monte Carlo planned	Derivatives or sensitivities are computed numerically
Experimental effects	Modeling of experimental effects	Method and algorithm selection	Doppler broadening and resolution functions

An efficient software class diagram should enable implementation of as many anticipated features as possible so that features can be added subsequently within the class structure of the code established. A class diagram designed for the Fit API mentioned above showing the method names is provided in Fig. 2.

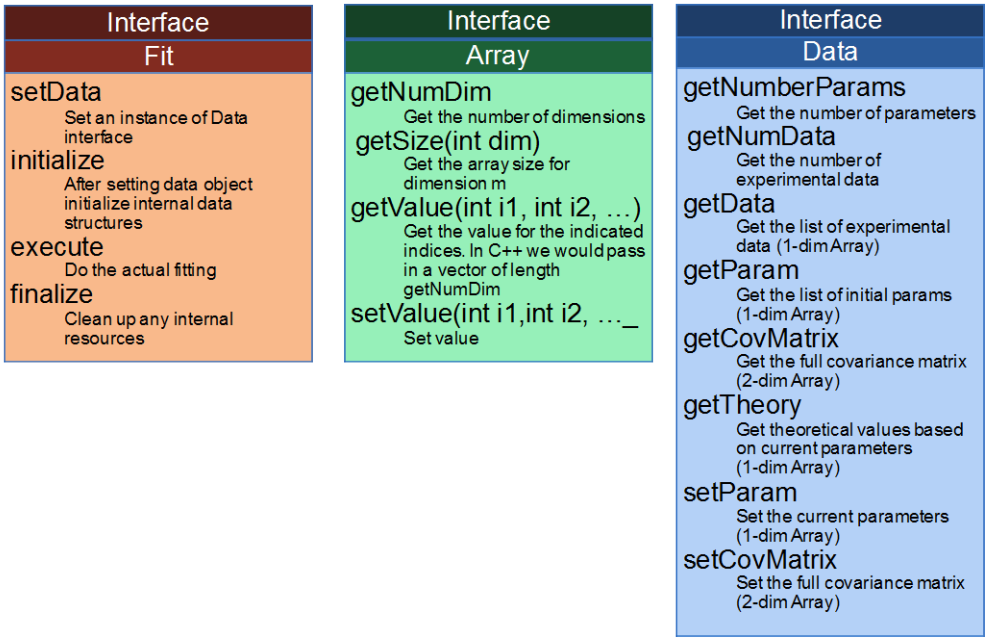


Fig. 2. Fit API class diagram.

A modern C++ implementation of the Fit API is based on the concept of generalized data that drastically simplifies the matrix equation governing optimization of R-matrix resonance parameters. For example, application of Newton-Raphson update equation to generalized data yields a formally simple matrix equation [4]. This simple equation is more general and much simpler in form than equations

implemented in the legacy SAMMY that do not use generalized data.[1] Various components of the generalized data covariance matrix are shown in Fig. 3, where *M* is the resonance parameters covariance matrix; V11 and V22 are data covariance matrices of data sets 1 and 2, respectively; and V12 is their cross-covariance.

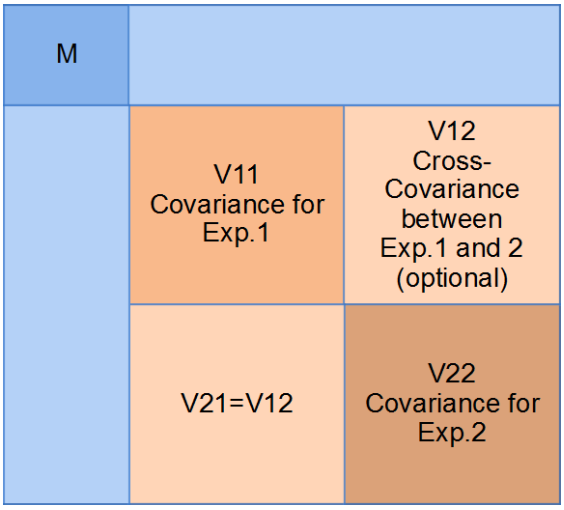


Fig. 3. Block view of generalized data covariance matrix implemented in modernized SAMMY.

SAMMY will be modernized incrementally by replacing legacy FORTRAN modules with their corresponding modernized C++ modules, one after another, by virtue of defining a C++ API for each module being modernized. Although this may seem cumbersome, this method will enable transparent swapping between the legacy FORTRAN and the modernized C++ implementations of this module's API. The legacy FORTRAN 77 implementation of this API will be accomplished by creating a FORTRAN 95 module that is a verbatim copy of the legacy FORTRAN 77 code and then converting it into an implementation of the C++ API. With the legacy and the modernized implementations of the same C++ API, SAMMY test cases will be run for both. The results of the legacy FORTRAN version will be used as benchmarks in the process of adopting each new modernized C++ module.

3. MODERNIZED SAMMY SOFTWARE QUALITY ASSURANCE

The legacy SAMMY 8.0.0 has been converted into the modern SQA framework that was recently established for SCALE and AMPX development and release control. This conversion effort included upgrading the SAMMY build system to a versatile, multiplatform *cmake* utility and upgrading all of the 180+ extant SAMMY test cases to work with the *ctest* utility. This upgrade required that a parser program be written to automate conversion of SAMMY input files for existing test cases into a format appropriate for the ctest. Also, utility C++ programs were written to parse SAMMY output files to extract numerical results and compare them to verified legacy results preserved in files, with user-specified maximum difference between new and reference test results. This SQA framework includes the following key components:

a) Source code version control system (Mercurial, to be replaced by git)
b) Automated build system for various platforms (*cmake*)
c) Automated test system with user specified precision (*ctest*)

[1] Generalized data are comprised of a union of model parameters and measured data.

d) Case management and bug tracking (Fogbugz, to be migrated to git)

The automated build and testing of the legacy SAMMY 8 code was enabled on the following combinations of FORTRAN compilers and operating systems:

a) GNU gfortran (versions 4 and 5), Linux, Mac OSX
b) Intel ifort FORTRAN compiler, Windows

4. SAMMY 8.1.0 RELEASE FEATURES

ORNL has officially released SAMMY 8.1 via RSICC (rsicc.ornl.gov); the release was announced in the RSICC April 2017 Newsletter. New features in this release include:

a) The auxiliary code SAMINT is distributed with SAMMY [5]. SAMINT can be used to fine tune mean values of SAMMY R-matrix resonance parameters by leveraging integral benchmark data, in addition to the customary differential experimental data.

b) New detector resolution functions were included based on Monte Carlo N-Particle (MCNP) simulations for standard liquid scintillator detector EJ-301, and for the Rensselaer Polytechnic Institute (RPI) Mid-Energy (keV region) ^{6}Li-glass Neutron Detector Array (MELINDA).

c) SAMMY's physical constants were modified to achieve consistency with AMPX and NJOY, whose constants were already updated.

d) SQA was improved by modernized build, test, version control, and bug tracking processes that are also used by SCALE and AMPX for anticipated code sharing among ORNL codes.

5. MODERNIZATION OF SAMMY METHODS

In the process of revisiting the mathematical and physical origins of methods implemented in the legacy SAMMY, several potentially useful new features have been revealed that could lead to immediate new functionality in the modernized version of SAMMY and could provide a platform to expand SAMMY features. Revisited methods used by the legacy SAMMY include the following:

a) By default, the legacy SAMMY uses an energy-dependent boundary condition, $B_c=S_c(E)$, that introduces an approximation. This approximation is recommended in seminal papers on R-matrix theory [6]; however, it leads to some deviations from the formally exact cross sections. These deviations occur mostly in the valleys between resonant peaks, and they were revealed in comparison with other R-matrix codes. The most straightforward method to undo this approximation would be to replace the boundary condition by any energy-independent boundary conditions, such as $B_c=-l_c$, and then extend the summation over channels that are currently restricted to open channels to closed channels, as well.
b) Alternatively, the energy-dependent boundary condition, $B_c=S_c(E)$, stated in item *a* above, could be made exact by an alternative or physical R-matrix parameterization derived by Prof. Carl Brune [11]. This alternative parameterization may be included in the evaluated nuclear data file (ENDF), because the alternative resonance energies and widths closely correspond to positions and widths of the peaks visible in the cross sections.

c) The legacy SAMMY only fits one particle pair in the incoming channel at a time, when all possible incoming particle pairs leading to the same compound nuclear resonance should be fitted simultaneously.
d) In the legacy SAMMY, only one normalization constant can be fitted by SAMMY, even when fitting more than one data set; each data set should have its own normalization constant parameter.
e) Bayesian parameter fitting method, also known as *generalized least squares* (GLS), was implemented in the legacy SAMMY. This method has been revisited, and a more general method has been derived for implementation of the Fit API [8]. The GLS method has now been implemented in a modernized framework for backward compatibility with the legacy SAMMY.
f) In the process of revisiting the conventional Reich-Moore approximation (of the full R-matrix) implemented in SAMMY, a generalization of the Reich-Moore approximation has been derived. This transparently unitary generalization formally yields particle cross sections identically equal to those of the full R-matrix [7], and it may be considered for implementation in future versions of modernized SAMMY.

Coulomb wave functions are needed for computation of penetrability functions in the expressions for *R*-matrix cross sections. Complex data type parameters are not allowed. To address shortcomings and domain restrictions of the legacy implementations of Coulomb functions used by SAMMY, an ORNL Software License Agreement (SLA) has been negotiated for a precise, modern implementation of Coulomb Wave Function code CWCOMPLEX, that can now be used and distributed by SAMMY, AMPX, SCALE, or any other ORNL code. This implementation is numerically stable in the few cases that are difficult to compute and where other implementations fail. The code significantly extends the range and types of input parameters, and it will replace previous generations of Coulomb functions currently used in AMPX and SAMMY. This SLA may be used as a template for negotiating similar agreements in the future. The code CWFCOMPLEX was published by Nicolas Michel [9].

6. SUCCESSION PLANNING

Over the past few years, three graduate student summer interns (Jinghua Feng, Christopher Chapman[2], and Amanda Youmans), one postdoctoral researcher (Andrew Holcomb[3]), and two research staff members (Vladimir Sobes and Marco Pigni) were introduced to the SAMMY code by Drs. Goran Arbanas and Dorothea Wiarda.

During the summer of 2017, a Nuclear Engineering Science Laboratory Synthesis (NESLS) summer intern, **Jinghua Feng**, prototyped a generalized least squares (GLS) implementation of the Fit API using the cpp-array interface to the BLAS library. Feng is a PhD graduate student of Prof. Emily (Li) Liu in the Nuclear Engineering Program at the Rensselaer Polytechnic Institute, Troy, NY. He also prototyped a novel Bayesian generalized data Monte Carlo implementation of the Fit API during his stay at ORNL [8]. Feng's planned contributions to the SAMMY modernization effort may lead to a PhD thesis project that would train him for long-term development of nuclear data evaluation methods in the modernized SAMMY framework.

ORNL postdoctoral research associate, **Dr. Andrew Holcomb**, translated the prototype GLS method implemented by Feng to conform to the Fit API of the modernized SAMMY framework, thus producing an important backward-compatible parameter optimization method. This and any other parameter optimization method that implements Fit API could be used by all other modules of SCALE and AMPX.

[2] Dr. Chapman received his PhD from Georgia Institute of Technology for his work developing the thermal neutron scattering framework [12] and joined the Nuclear Data & Criticality Safety Group as a postdoctoral research associate.
[3] Dr. Holcomb joined the Nuclear Data & Criticality Safety Group as a full-time research staff member.

ORNL research staff members who contributed to the SAMMY 8.1 release are Drs. Vladimir Sobes and Dorothea Wiarda. **Dr. Sobes** has contributed the SAMINT module that fine tunes mean values of R-matrix resonance parameters to achieve a better agreement between integral benchmark simulations and measurements [5], and he has created new SAMINT test cases. **Dr. Wiarda** has introduced the modern SQA of SCALE and AMPX to SAMMY, and she has also introduced robust methods for a piecemeal replacement of select legacy FORTRAN modules in SAMMY by their corresponding C++ API–based modernized modules, thus ensuring that legacy SAMMY results are reproduced by the modernized SAMMY at each step of the modernization. Summer intern **Amanda Youmans** has contributed high-fidelity liquid-scintillator and lithium glass detector resolution functions for improved data evaluations.

Following the release of SAMMY 8.1, **Dr. Marco Pigni** introduced summation over closed channels into the SAMMY implementation of cross section calculations. This was necessary to enable comparison of cross sections computed by SAMMY with other R-matrix codes at the International Atomic Energy Agency (IAEA) Consultants' Meeting, "R-Matrix Codes for Charged-particle Induced Reactions in the Resolved Resonance Region" (IAEA Vienna) described below in Section 8, "Travel and Conferences."

Dr. Chris Chapman developed a thermal neutron scattering kernel evaluation capability to be included in the modernized version of SAMMY to enable first-time simultaneous fitting of R-matrix resonance parameters and thermal neutron scattering libraries. This will result in improved consistency and covariance data between the two corresponding energy ranges. Thermal neutron scattering data were measured by the RPI collaborators at ORNL's Spallation Neutron Source.

Dr. Vladimir Sobes prepared a hands-on R-matrix course for nuclear data evaluators. The course was recently conducted at RPI and the Massachusetts Institute of Technology (MIT) to educate the new generation of nuclear engineers about the vital importance of nuclear data.

7. SUMMARY AND PATH FORWARD

During FY 2017, SAMMY 8.1.0 was released in a modern SQA and development framework shared with modernized SCALE and AMPX, enabling a modular API-based development of features in C++. This design decision enabled leveraging of the modernized AMPX Resonance API for computation of cross sections by the modernized SAMMY. A new Fit API was designed for fitting R-matrix resonance parameters. The first implementation of Fit API has been the GLS for backward compatibility with the legacy SAMMY. During FY 2018 SAMMY 8.2 will be released with the following anticipated features:

a) An API will be created for Coulomb functions to enable transparent replacement of various Coulomb function implementations, such as Prof. Nicolas Michel's modern implementation when legacy implementations fail [9].
b) Summation will be expanded over open channels in SAMMY to include closed channels. This will make it consistent with R-matrix formalism and will provide for comparison with other R-matrix codes that include closed channels.
c) The Brune transform [11] between formal and physical R-matrix parameters will be implemented.
d) A complete covariance matrix will be enabled for angular distributions of reaction channels currently not enabled in the legacy SAMMY.
e) Distinct normalization coefficients will be enabled, one per data set, to fulfill a missing feature in the legacy SAMMY in which a single normalization coefficient has been used for all data sets.
f) Simultaneous fitting of R-matrix resonance parameters will be enabled. The parameters correspond to compound nuclear resonances that are reachable by various incoming particle pairs, or various projectile-target pairs. This is another missing feature of the legacy SAMMY. To illustrate, ^{7}Be compound resonances can be reached via protons incident on ^{6}Li and via α-particle incident on ^{3}He,

both leading to the same compound resonant state. Contributions of direct reaction amplitudes, however, will be different in the two reactions.

g) An I/O API will be implemented that could read/write SAMMY input files for backward compatibility.

To the extent that time and funding allows, effects related to experimental conditions will be implemented in the modernized framework during FY 2018, including:

a) Doppler broadening via Solbrig's kernel, ideally implemented using the fast Gauss transform
b) Resolution broadening as a convolution of various resolution functions for backward compatibility with the legacy SAMMY
c) Modeling of the experimental background by parameterized functions
d) High-fidelity modeling of experimental effects (e.g., multiple scattering) by seamless linking to ORNL's high performance computing (HPC) SHIFT Monte Carlo neutron transport code via its API.

With Doppler-broadening and either RPI or GEELINA experimental resolution functions implemented, work can begin to fit differential cross sections data, including experimental broadening. This would enable realistic fits to be performed completely within the modernized SAMMY framework.

In the process of revisiting the mathematical and physical origins of methods implemented in the legacy SAMMY code, several potentially useful new features were discovered that could be implemented in the modernized framework.

For example, revisiting the conventional application of Bayes' theorem to nuclear data evaluations in SAMMY led to a derivation of a new evaluation scheme that could be applied simultaneously to R-matrix resonance parameters and to parameters that define integral benchmark experiments (e.g., dimensions, material composition). This would optimize overall agreement with differential *and* integral measured data [8], and it would provide a simultaneous, consistent evaluation method of differential and integral data. In turn, this would yield a covariance of integral benchmark experiments. In addition to this benefit, this method is designed to account for any known model defects. The derivation of this method was accomplished during the summer of 2017, and it will be presented at and published in the proceedings of the 4th International Workshop on Nuclear Data Covariances (organized by CEA Cadarache and NEA, Aix en Provence, France, October 2–6 2017). The new method will be implemented in the modernized SAMMY via the Fit API described earlier.

In another example, collaboration with Prof. Dean W. Halderson of Western Michigan University was initiated in FY 2017 to consider accurate calculation of relativistic effects that may be useful for resonant cross section evaluations of light nuclides for which resolved resonance range may extend into 10s of MeV, where relativistic effects may be tangible. This would constitute the first attempt to use Dirac relativistic R-matrix formalism in a nuclear data evaluation framework for improved precision and accuracy. This R-matrix formalism could be used in the modernized version of SAMMY.

Christopher Chapman defended his PhD thesis entitled "Thermal Neutron Scattering Evaluation Framework" at the Georgia Institute of Technology on June 23, 2017. The thesis is a product of research on thermal neutron scattering evaluation and uncertainty quantification of water conducted at ORNL over the past 2 years. Dr. Chapman has recently been investigating the feasibility of using the Path Integral Molecular Dynamics (PIMD) method that accounts for nuclear quantum effects that have been treated in extant thermal scattering libraries such as ENDF. The plan is to use PIMD in FY2018 to evaluate water and other hydrogenous materials for which quantum effects are known to be significant. The feasibility of simultaneously evaluating thermal neutron scattering developed by Dr. Chapman will also be investigated, along with resolved resonance range in a unified framework of modernized SAMMY.

8. TRAVEL AND CONFERENCES

Goran Arbanas and **Vlad Sobes** visited Professor Yaron Danon's group at RPI, Troy, NY, November 3–-6, 2017, to anticipate the features needed in modernized SAMMY to analyze data at the modernized Gaerttner Linear Accelerator Center. Dr. Sobes presented a course on R-matrix formalism to graduate students and SAMMY users.

At the Cross Section Evaluation Working Group, Nuclear Data Week held at Brookhaven National Laboratory in November of 2016, Goran Arbanas presented a preliminary framework for the modernized version of the ORNL nuclear data evaluation code SAMMY. The presentation highlighted recently developed features of the modernized SCALE/AMPX framework that will be leveraged by the modernized SAMMY code. A summary was given of the recently developed generalized Reich Moore approximation and its relation to alternative R-matrix parameterization. This is to be implemented in the modernized version of the SAMMY code.

Goran Arbanas was invited to participate in the 2016 IAEA 2nd Consultants' Meeting on R-Matrix Codes for Charged-particle Induced Reactions in the Resolved Resonance Region, December 5–7, 2016. During the formal presentation session on December 6, he gave presentations entitled "SAMMY Modernization" and "Generalized Reich-Moore R-matrix Approximation" [8]. The first presentation outlined how SAMMY modernization is leveraging the modern software development framework used for SCALE development. The second presentation provided a mathematical proof for the unitarity of Reich-Moore approximation implemented in the legacy code SAMMY and its generalization planned for the modernized version of SAMMY. For more information, please visit: https://www-nds.iaea.org/index-meeting-crp/CM-R-matrix-2016/ .

Marco Pigni was invited to participate at the 3rd Consultants' Meeting on *R*-matrix Codes for Charged-particle Induced Reactions in the Resolved Resonance Region to compare angular differential cross sections computed by the SAMMY Code to other *R*-matrix codes for the ^{7}Be resonance analysis in p+^{6}Li and ^{3}He+^{4}He reactions. For more information please visit: https://www-nds.iaea.org/index-meeting-crp/Rmatrix2017/ .

9. REFERENCES

1. N. M. Larson, *Updated Users' Guide for SAMMY: Multi-level R-matrix Fits to Neutron Data Using Bayes' Equations*, ORNL/TM-9179/R8 (2008).
2. B. T. Rearden and M. A. Jessee, Eds., *SCALE Code System*, ORNL/TM-2005/39, Version 6.2.1, Oak Ridge National Laboratory, Oak Ridge, Tennessee (2016). Available from the Radiation Safety Information Computational Center as CCC-834.
3. D. Wiarda et al., *AMPX 6: A modular code system for processing ENDF/B*, ORNL/TM-2016/43 (2016).
4. F. Froehner, *Evaluation and Analysis of Nuclear Resonance Data*, JEFF Report 18 (2000).
5. V. Sobes, L. Leal, G. Arbanas, and B. Forget, "Resonance Parameters Adjustment Based on Integral Experiments," *Nucl. Sci. Eng.*, **183**, 347–355 (2017).
6. A. M. Lane and R. G. Thomas, "R-matrix Theory of Nuclear Reactions," *Rev. Mod. Phys.* **30**, 257 (1958).
7. G. Arbanas et al., "Generalized Reich-Moore Approximation," *Proceedings of the International Conference on Nuclear Data and Applications*, Bruges, Belgium, September, 2016, EPJ Web of Conferences 146, 12006 (2017) https://doi.org/10.1051/epjconf/201714612006.
8. G. Arbanas et al., "Bayesian Generalized Data Optimization Method," *Proceedings of the 4th International Workshop on Nuclear Data Covariances*, Aix En Provence, France, October 2–6, 2017, forthcoming in *EPJ-N Nuclear Science and Technologies* (2018).

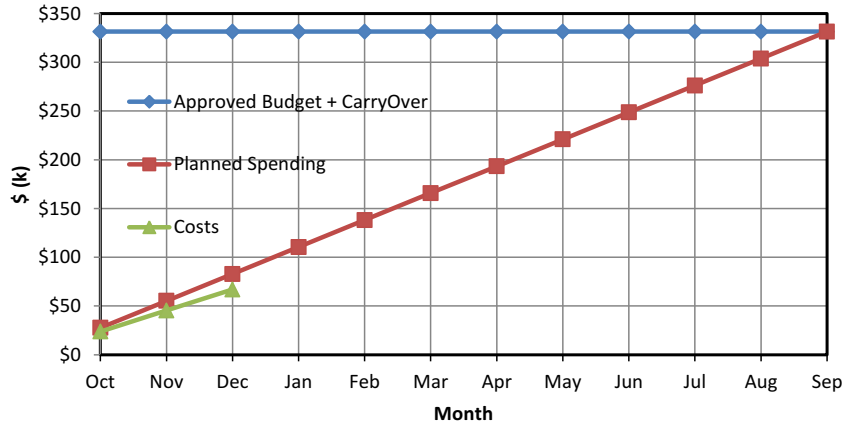
9. Nicolas Michel, "Precise Coulomb wave functions for a wide range of complex ℓ, η and z," *Computer Physics Communications*, Volume 176, Issue 3, 1 February 2007, 232–249, http://doi.org/10.1016/j.cpc.2006.10.004.
10. A. M. Aragón, "A C++11 implementation of arbitrary-rank tensors for high-performance computing," *Computer Physics Communications*, **185**, 1681–1696, (2014).
11. C. R. Brune, "Alternative parameterization of R-matrix theory," *Phys. Rev.* **C 66**, 04461 (2002).
12. C. Chapman, PhD Thesis, *Thermal Neutron Scattering Evaluation Framework,*" Georgia Inst. of Tech. (2017); https://smartech.gatech.edu/handle/1853/58693.

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: RPI-ND1- Resonance Region Nuclear Data Measurement Capability at RPI - Perform cross-section measurements and qualification of the new capabilities
M&O Contractor Name: RPI
Point of Contact Name: Yaron Danon
Point of Contact Phone: 518-276-4008

Reference: RPI ND-1
Date of Report: January 26, 2018

BUDGET



1. Carryover into FY-18: $-8,520
2. Approved FY-18 budget: $340,000, $331,480 (with carryover),
3. Actual spending through the end of this quarter in FY-18: $66,956
4. Projected carryover into FY-19: $10,000

ACCOMPLISHMENTS

Q1 accomplishments:

- Completed data reduction and analysis of Ta transmission measurement at 100m time-of-flight station.
- Completed data reduction and analysis of Ta capture measurement at 45m time-of-flight station.
- Submitted a publication on Ta for the upcoming ANS conference

MILESTONES

1. Complete analysis of measurements from FY-17 (Ta samples) (Q1).	
2. Complete transmission measurement per the nuclear data schedule in Appendix B (Q3) (additional Ta data as needed)	
3. Complete capture measurement per the nuclear data schedule in Appendix B (Q3) (additional Ta data as needed)	
4. Complete data analysis for transmission and capture measurements and provide the data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B.(Q4)	
5. Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (All Q).	
6. Provide status reports on RPI participation in US and International Nuclear Data collaborations and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (All Q).	

ISSUES/PATH FORWARD

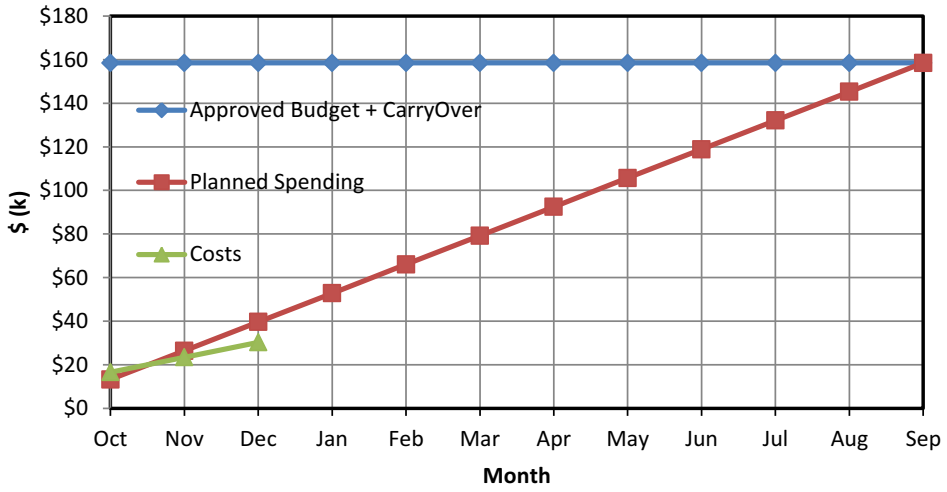
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: RPI-ND2- Thermal neutron scattering measurements
M&O Contractor Name: RPI
Point of Contact Name: Yaron Danon
Point of Contact Phone: 518-276-4008

Reference: RPI ND-2
Date of Report: January 26, 2018

BUDGET



1. Carryover into FY-18: $32,481
2. Approved FY-18 budget: $126,000, $158,481 (with carryover)
3. Actual spending through the end of this quarter in FY-18: $30,268
4. Projected carryover into FY-19: $15,000

ACCOMPLISHMENTS

Q1 Accomplishments

- Completed a library for Lucite that is ready for testing.
- Implemented changes to NJOY-2016 and created new Quartz library that is ready for testing.
- Completed Polyethylene manuscript.
- Presented data on Lucite and Teflon at 2017 ANS Winter Meeting 2017.

MILESTONES

1. Complete thermal scattering measurements per the nuclear data schedule in Appendix B (Q3) (these are repeat measurment if needed)	
2. Complete thermal scattering data analysis and provide data to ORNL as needed to support the evaluation effort per the nuclear data schedule in Appendix B (Q4).	
3. Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (All Q).	
4. Provide status reports on RPI participation in US and International Nuclear Data collaborations, and for foreign travel, provide a brief trip summary report to NCSP Manager on items of NCSP interest (All Q)	

ISSUES/PATH FORWARD

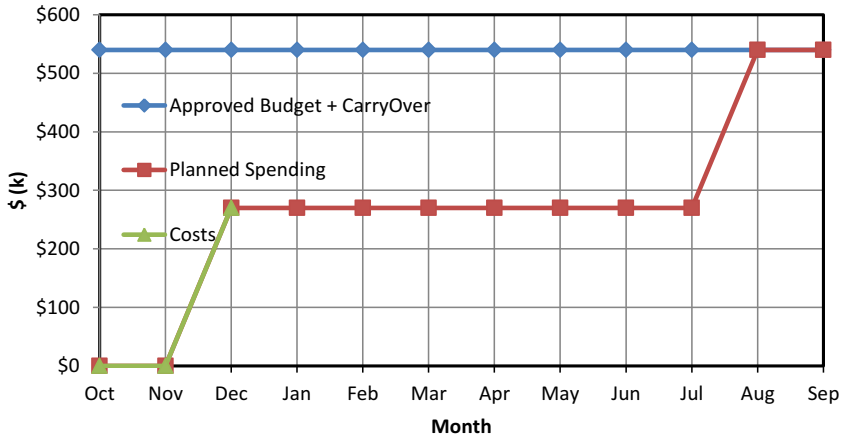
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: RPI-ND3- LINAC 2020 plan, Nuclear Data Capabilities Maintenance plan
M&O Contractor Name: RPI
Point of Contact Name: Yaron Danon
Point of Contact Phone: 518-276-4008

Reference: RPI ND-3
Date of Report: January 28, 2018

BUDGET



1. Carryover into FY-18: $0
2. Approved FY-18 budget: $960,000
3. Actual spending through the end of this quarter in FY-18: $960,000
4. Projected carryover into FY-19: $0

ACCOMPLISHMENTS

Accomplishments in Q1

- Accelerator sections in production.
- A 5th modulator was added to PO.
- A 6th Klystron is being fabricated.
- Construction of modulator building started at RPI

MILESTONES

1. Place accelerator sections contract with vendor (Q1)	
2. Complete 1st modulator factory test in coordination with NR (Q2)	
3. Complete modulator(s) factory test in coordination with NR. (Q4)	
4. Complete accelerator section(s) factory test in coordination with NR. (Q4)	
5. Provide status reports on all nuclear data support activities in NCSP Quarterly Progress Reports (Q1, Q2, Q3,Q4)	

ISSUES/PATH FORWARD

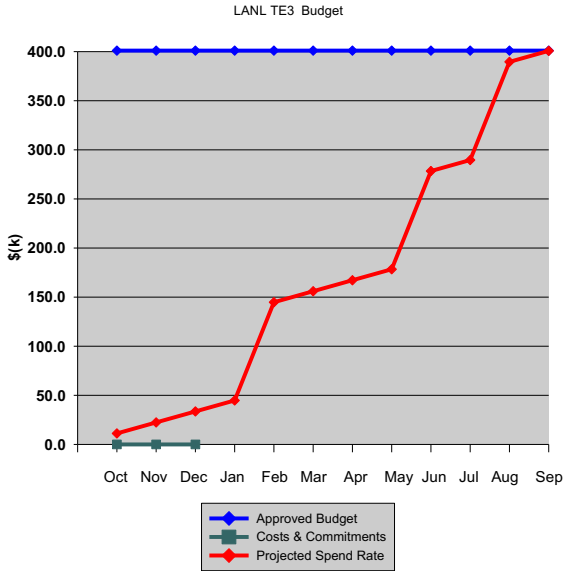
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element: Integral Experiments LANL TE 3
M&O Contractor Name: Los Alamos National Laboratory (LANL)
Point of Contact Name: Robert Margevicius
Point of Contact Phone: (505) 665-8965

Reference: B&R DP0902090
Date of Report: January 29, 2018

BUDGET



1. **Carryover from last FY-17: $38K**
2. **Total available funding this FY-18: $401K**
3. **Total spending through the end of the report quarter Q1: $0.0K**
4. **Carryover into new FY-19: $0.**

MAJOR ACCOMPLISHMENTS

- Participated in regularly scheduled NCSP T&E conference calls.

ISSUES/PATH FORWARD

- None

- None

NCSP Quarterly Progress Report (FY-2018 Q1) cont'd.

NCSP Element: Integral Experiments LANL TE3 **M&O Contractor Name:** Los Alamos National Laboratory (LANL) **Point of Contact Name:** Robert Margevicius **Point of Contact Phone:** (505) 665-8965		Reference: B&R DP0902090 Date of Report: January 29, 2018	
MILESTONES		**MILESTONES**	
• Provide class room and hands on training at LANL and at NCERC in accordance with the approved schedule and provide status reports on all training activities in the NCSP Quarterly Progress Reports. (Q1, Q2, Q3, Q4).			
1.		2.	
3.		**4.**	
5.		6.	
7.		8.	
9.		10.	
11.		12.	
13.		14.	
15.		16.	
17.		18.	
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23.		24.	
25.		26.	
27.		28.	
29.		30.	
31.		32.	
33.		34.	
35.		36.	
37.		38.	
39.		40.	
41.		42.	
43.		44.	

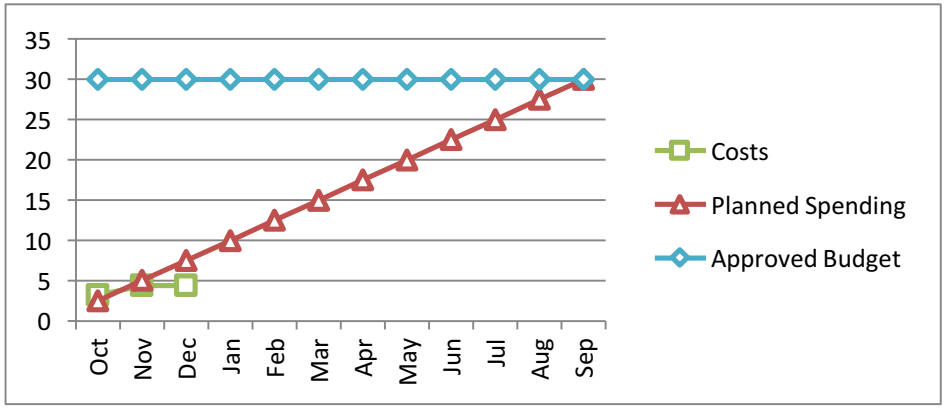
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed before or on Schedule, Purple = Completed Late

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: T&E4 (Training in Validation Techniques Using Modern S/U Tools)
M&O Contractor Name: LANL
Point of Contact Name: Bob Margevicius / Bob Little
Point of Contact Phone: 505-665-8965 / 505-665-3487

Reference: B&R DP0902090
Date of Report: January 28, 2018

BUDGET



- Carryover into FY-2018 = $0.
- Approved FY-2018 Budget = $29,000 (Includes carryover from FY-2017).
- Actual Spending through the end of this quarter in FY-2018 = $4,436.
- Projected carryover into FY 2019 = $0.

ACCOMPLISHMENTS

- The next target site is SNL. The class is currently planned for spring/summer 2018. Doug Bowen coordinates the scheduling of these classes.

MILESTONES

In collaboration with ORNL, provide introductory 1-day S/U workshop training to one or more DOE sites in FY2018 (TE4:Q4)	

ISSUES/PATH FORWARD

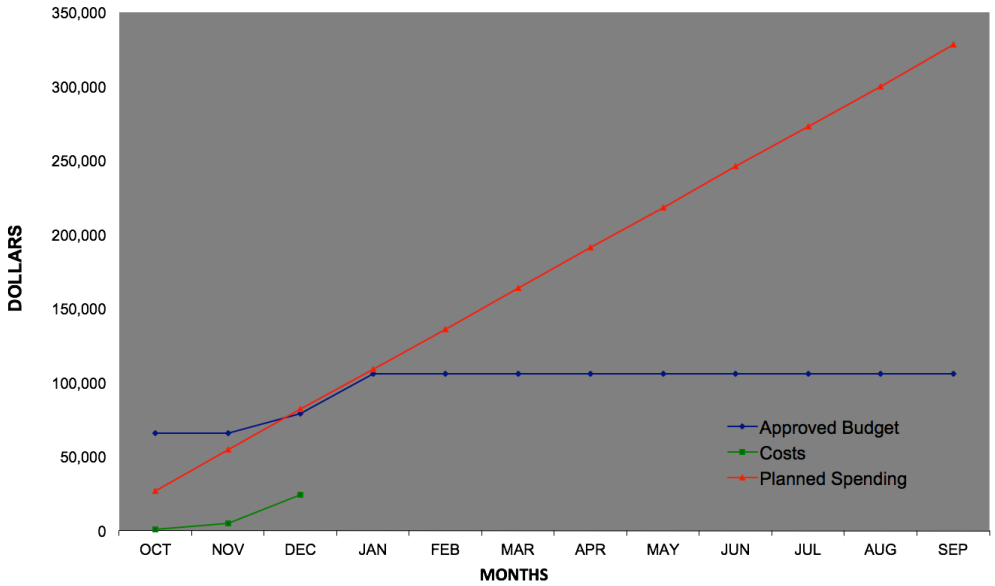
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY 2018 Q1)

NCSP Element and Subtasks: Training & Education,
"Hands-on" Training (TE1), Classroom Instruction (TE3), TACS with Be (TE8)
M&O Contractor Name: Lawrence Livermore National Laboratory
Point of Contact Name: David Heinrichs
Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: January 26, 2017

BUDGET



1. Carryover into FY-2018 = $0
2. Approved FY-2018 Budget = $356,000 (Includes carryover from FY-2017)
3. Actual Spending through the end of this quarter in FY-2018) = $24,138
4. Projected carryover into FY-2018 = $28,000 (8%)

ACCOMPLISHMENTS

- Provided registration and logistics support for:
  - 2-week CSE course on Jan. 29-Feb. 9, 2018
  - 1-week Managers course on April 15-20, 2018 at SNL
  - 1-week Managers course on June 11-15, 2018 at NFO/NCERC
  - 2-week CSE course on Aug. 13-24, 2018
- Transferred custody of legacy beryllium shells from LLNL GS to NCSD and completed ~30% of swipe testing and inspection and determined suitable for use. Briefed the DAF Steering Group on January 24, 2018 of the plan to incorporate these shells into TACS instruction.
- Finalized new Emergency Response Module for the 2-Week Hands-On CSE Course.
- Disassembled the TACS vertical lift machine, inspected all parts, and cleaned and lubricated all moving parts. Installed upper and lower locking collars to limit range of motion to preclude jamming at the upper and lower extremes. All parts found to be in excellent condition.
- Procured a new, long-life, Am-Be source to replace the short half-life ^{252}Cf source. The source is expected to be received in February 2018.
- Participated in all T&E teleconferences.

MILESTONES FY2018

Update, maintain and support the registration process and provide classroom and "hands-on" TACS training in accordance with the schedule approved by the NCSP Manager (TE1: All Qtrs).	
Provide LLNL support for FY2018 classroom instruction at the NSF or NATM and participate in T&E development activities in accordance with the schedule approved by the NCSP Manager (TE2: All Qtrs).	
Evaluate the TACS with Be shells and provide a status report in the FY2018 Q4 quarterly status report to the NCSP Manager (TE8: Q4).	

ISSUES/PATH FORWARD

- Approved budget reflects actual funds received on October 13, 2017, December 22, 2017, and January 12, 2018.
- Planned spending is from the 5YP, Table 2.5-5.

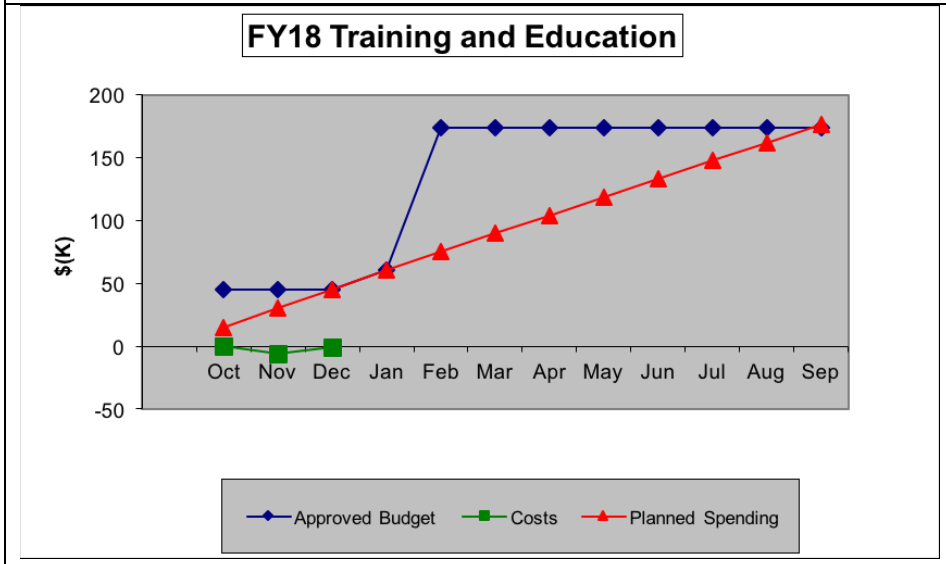
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: TE1 and TE5
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0902000/ORNL
Date of Report: January 26, 2018

BUDGET



1. **Carryover into FY 2017** = $0K
2. **Approved FY 2017 Budget** = $174K (includes carryover)
3. **Actual spending for 1st Quarter FY 2018 = $0K**
4. **Actual spending for 2nd Quarter FY 2018 = $0K**
5. **Actual spending for 3rd Quarter FY 2018 = $0K**
6. **Actual spending for 4th Quarter FY2018 = $0K**
7. **Projected Carryover into FY 2018** = $0K

ACCOMPLISHMENTS

- **TE1**:
  - Continued execution on CSSG assessment report comment resolution plan (CSSG tasking 2016-01). (% CSSG 2016-01 comments resolved: NFO –85%, NCERC–47%, Sandia–90%, Overall–70%). Completion is anticipated before the August 2-week Hands-on Course.
  - Began preparations for 2-week hands on course Jan. 29-Feb. 2, 2018. Conducted two telecons in Q1.
- **TE5**:
  - Began efforts to schedule a 1-day S/U introductory training course at SRNS sometime in Q2/Q3.

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: TE1 and TE5 **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315		**Reference:** DP0902000/ORNL **Date of Report:** January 26, 2018 **Page 2 of 2**
MILESTONES		**ISSUES/RESOLUTIONS**
	Status	
1. Provide a status report in NCSP Quarterly Progress Reports on implementation of the NCS training program and resolution of CSSG comments from CSSG tasking 2016-01. (TE1)		Spending light in Q1. Spending in Q2 and beyond will increase in preparation for the 2-week hands-on course in February 2018.
2. Provide status reports in NCSP Quarterly Progress Reports on improvements/modifications to baseline NCS course training materials based on CSSG assessment report 2016-01, self-evaluation, and feedback from reviewers, observers, trainers, and the NCSP manager. (TE1)		
3. Provide a status report in NCSP Quarterly Progress Reports on the progress of 1-day onsite introductory validation training conducted at one or more DOE sites. (TE5)		

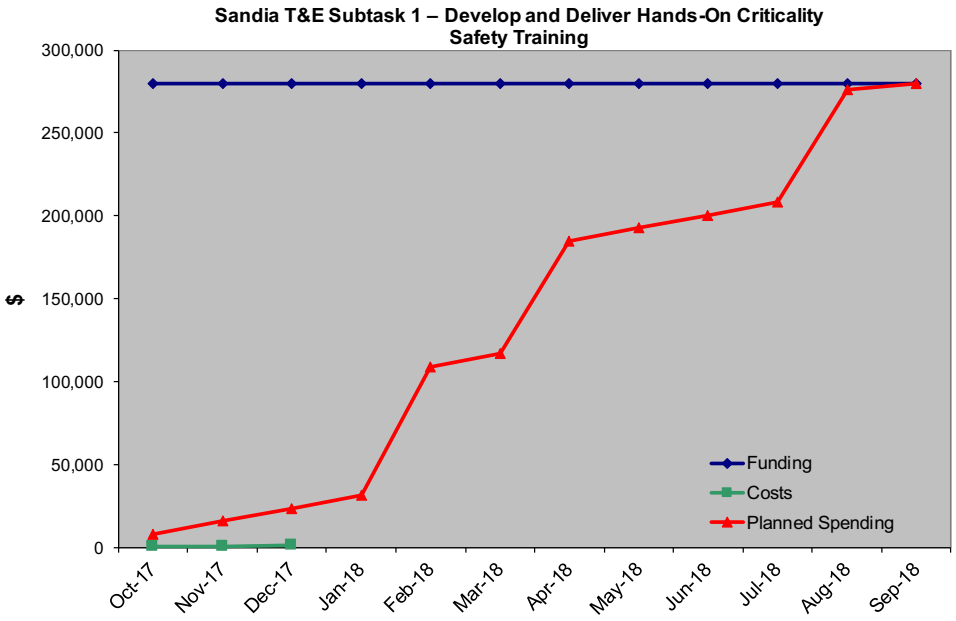
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element: Sandia T&E Task 1 – Conduct Criticality Safety Training Classes
M&O Contractor Name: Sandia National Laboratories (SNL)
Point of Contact Name: Gary A. Harms
Point of Contact Phone: (505)845-3244

Reference: B&R DP 0909010
Date of Report: December 31, 2017

BUDGET



1. Carryover from the Previous FY = $170,000
2. Approved Current FY Budget = $110,000 + $170,000 (carryover) = $280,000
3. Costs at the End of the Quarter = $1,288
4. Carryover into the Next FY = $0

ACCOMPLISHMENTS

- We are preparing to deliver the experimental portion of a Hands-On criticality safety course for NCSEs in February 2018.

MILESTONES

Conduct hands-on training classes at Sandia and provide Human Factors and Equipment Reliability module support to the training courses in accordance with the approved schedule (TE1: All Qtrs). 

ISSUES/PATH FORWARD

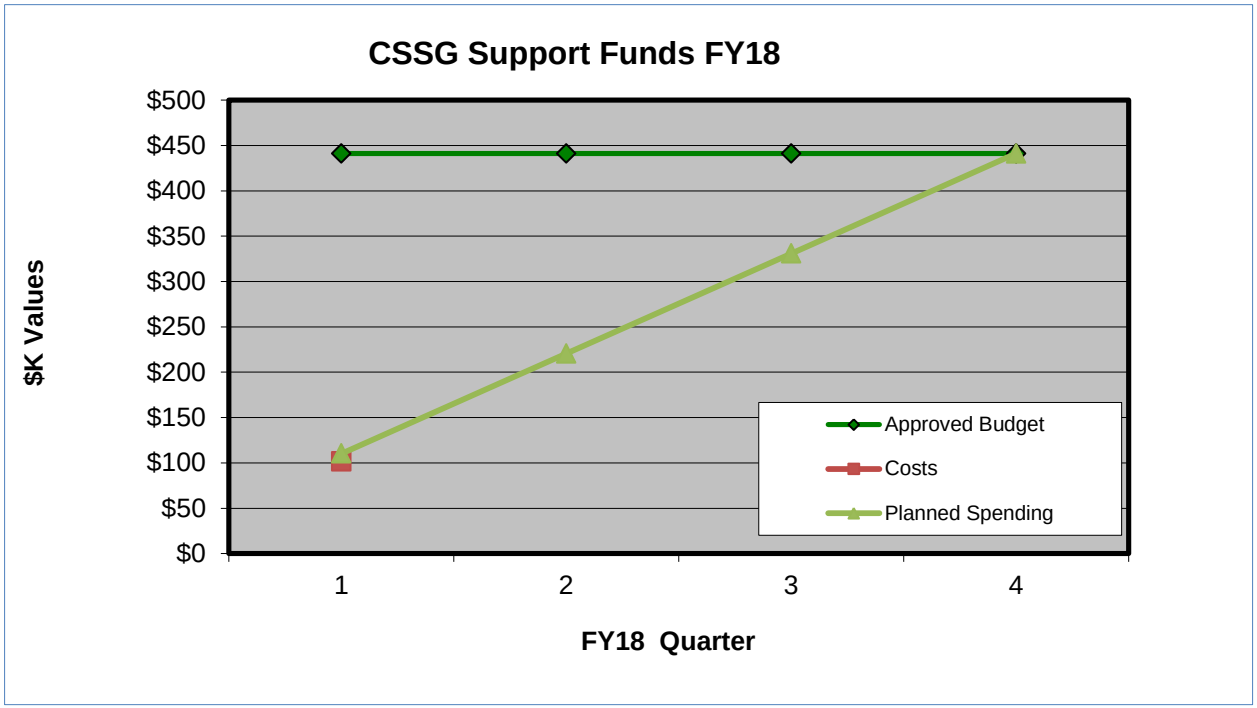
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY18 Q1)

NCSP Element and Subtask: CSSG Support
M&O Contractor Name(s): AECOM, ANL, LANL, LLNL, PNNL, SRNS, Y-12
Point of Contact Name: David Hayes (CSSG Deputy Chair)
Point of Contact Phone: 505-667-4523

Reference: B&R DP 0902010
Date of Report: January 26, 2018

BUDGET



a) Total Budget for FY18 = $441K
b) Actual Total Spending for FY18 = $101K
Q1 = $101K, Q2 = $0K, Q3 = $0K, Q4 = $0K

ACCOMPLISHMENTS

- CSSG Chair/Deputy duties
- CSSG conference calls
- Prepare/Review taskings/responses (2016-04, 2017-03, 2017-04, 2017-05)
- CSSG Face to Face Meeting

MILESTONES

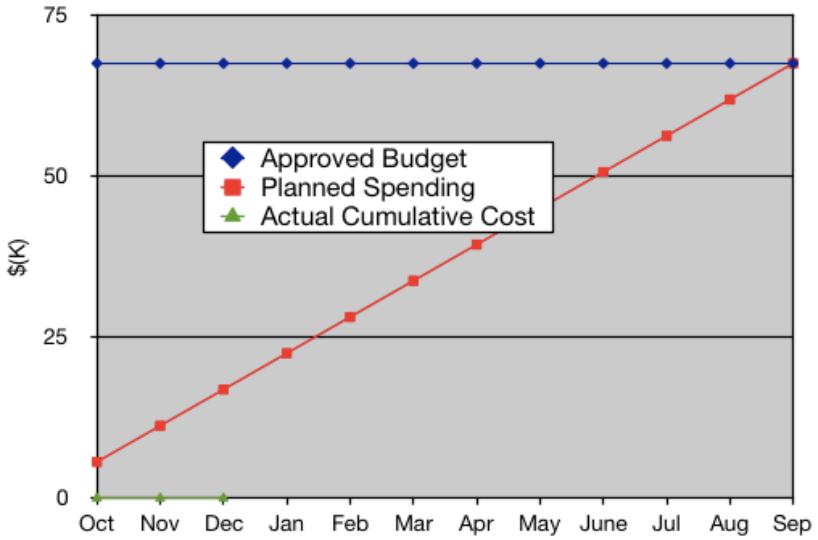
Tasking 2016-04 Position of the CSSG on Natural Phenomena and Other Extreme Events vis-a-vis ANSI/ANS-8 Standards	
Tasking 2017-03 Comment resolution for DOE-STD-3007-2017	
Tasking 2017-04 CSSG Review of LANL CSP	
Tasking 2017-05 CSSG Assessment of SRNS NCS Program	

ISSUES/PATH FORWARD

2016-04 Final wrap up in progress with completion estimated in JAN18.

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element and Subtask: NCSP Technical Support Task 6 M&O Contractor Name: BNL Point of Contact Name: David Brown Point of Contact Phone: 631-344-2814	Reference: B&R DP 0902090 Date of Report: Jan 25, 2018
BUDGET	**ACCOMPLISHMENTS**
 1. Carryover into FY-2018 = $0 2. Approved FY-2018 Budget = $67,566 (Includes carryover from FY-2017) 3. Actual Spending through the end of this quarter in FY-2018 = $0	· Work on this task has not yet begun · *Atlas of Neutron Resonances, 6th edition* available for pre-order
MILESTONES	**ISSUES/PATH FORWARD**
Provide NCSP Manager annual report of succession planning efforts (Q4) 	

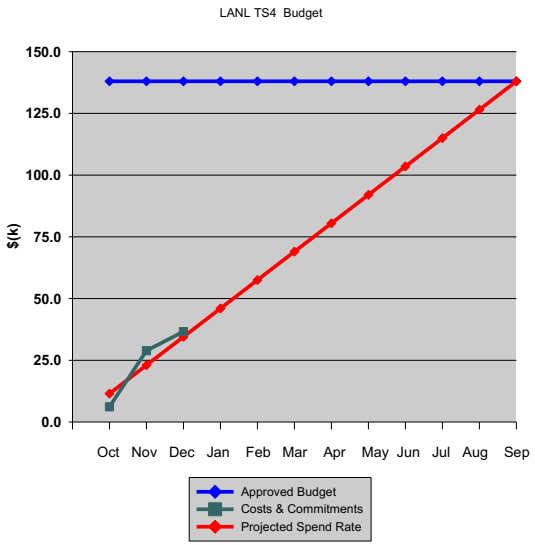
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element: Integral Experiments LANL TS4
M&O Contractor Name: Los Alamos National Laboratory (LANL)
Point of Contact Name: Robert Margevicius
Point of Contact Phone: (505) 665-8965

Reference: B&R DP0902090
Date of Report: January 29, 2018

BUDGET



1. **Carryover from last FY-17: $0.**
2. **Total available funding this FY-18: $138.0K**
3. **Total spending through the end of the report quarter Q1: $36.6K**
4. **Carryover into new FY-19: $0.**

MAJOR ACCOMPLISHMENTS

- George McKenzie was preparing a draft of his PhD dissertation entitled "Area of Application for Relating Reactivity to Rossi-Alpha".

ISSUES/PATH FORWARD

- None

- None

NCSP Quarterly Progress Report (FY-2018 Q1) cont'd.

NCSP Element: Integral Experiments LANL TS4 **M&O Contractor Name:** Los Alamos National Laboratory (LANL) **Point of Contact Name:** Robert Margevicius **Point of Contact Phone:** (505) 665-8965		Reference: B&R DP0902090 Date of Report: January 29, 2018	
MILESTONES		**MILESTONES**	
• Provide status reports on succession planning activities in the NCSP Quarterly Progress Reports. (Q1, Q2, Q3, Q4).			
1.		2.	
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47.		48.	

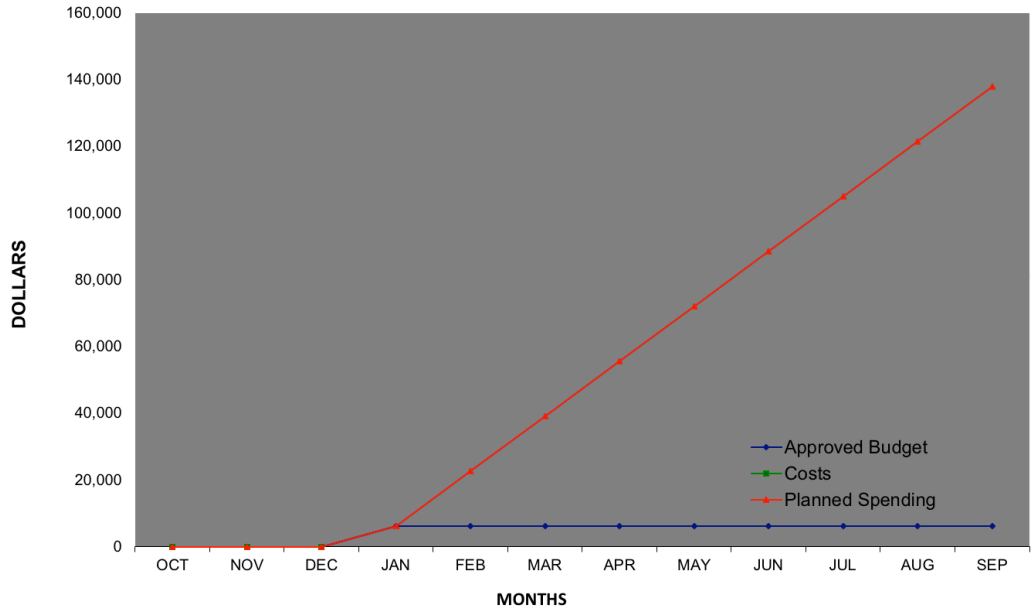
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed before or on Schedule, Purple = Completed Late

NCSP Quarterly Progress Report (FY 2018 Q1)

NCSP Element and Subtasks: Technical Support
LLNL Succession Planning (TS5)
M&O Contractor Name: Lawrence Livermore National Laboratory
Point of Contact Name: David Heinrichs
Point of Contact Phone: (925) 424-5679

Reference: B&R DP0909010
Date of Report: January 26, 2018

BUDGET



1. Carryover into FY-2018 = $0
2. Approved FY-2018 Budget = $138,000 (Includes carryover from FY-2017)
3. Actual Spending through the end of this quarter (in FY-2018) = $0
4. Projected carryover into FY-2019 = $0 (0%)

ACCOMPLISHMENTS

LLNL Succession Planning (TS5)

- Provided LLNL-AR-742148, "LLNL NCSP Succession Planning Efforts in FY-2017," to the NCSP Manager on November 16, 2017.

MILESTONES FY2018

Provide NCSP Manager annual report of succession planning efforts (TS5).	

ISSUES/PATH FORWARD

- LLNL TS5 expenditures delayed one quarter due to Continuing Resolution; however, LLNL TS1 (CSSG) is instead fully funded. Planned spending assumes additional funding received in February.

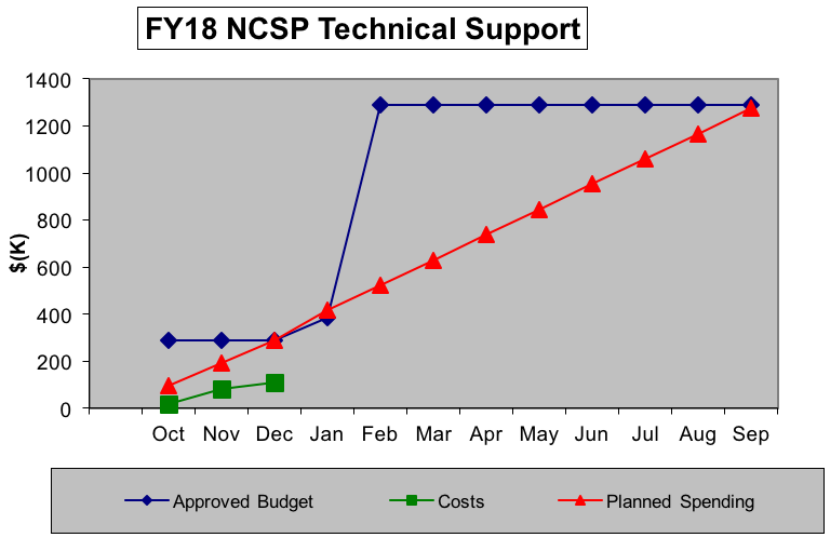
Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype), TS11 (CEdT Manage Support)
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0902000/ORNL
Date of Report: January 27, 2018

BUDGET



1. **Carryover into FY 2018** = $5K
2. **Approved FY 2017 Budget** = $1,294K (includes carryover)
3. **Actual spending for 1st quarter FY 2017** = $110K
4. **Actual spending for 2nd quarter FY 2017** = $0
5. **Actual spending for 3rd quarter FY 2017** = $0
6. **Projected carryover into FY 2018** = $0

ACCOMPLISHMENTS

NCSP TS2 Program MGT and Execution of the NCSP

- Prepare and maintain elements of NCSP Plan and associated activities:
  - Monitor Five-Year Plan progress,
  - Review/revise task list, and
  - Schedule/participate in meetings and teleconferences.
  - Manage and provide oversight/coordinate efforts for the NCSP Information, Preservation, and Dissemination task element.
  - Manage and provide oversight/coordinate efforts for the NCSP Training and Education Program task element.
- Participated in weekly NCSP management team and other NCSP-related meetings, as required by the NCSP Manager.
- Bowen met with Tim Wynn (ORNL) and Ty Deschamp (NA-50) in Knoxville, TN, on Nov. 27, 2018 about tracking IERs in the G2 system. Bowen provided the team an overview of the NCSP and the IER process, including an overview of the 5-year plan preparation process for future reference in developing a new system.
- Prepared Q4 QPRs into a single bookmarked PDF file for use in QPR. Conducted Q4 telecon.
- Published NCSP fall newsletter
- Redefined the process for tracking non-NCSP funded tasks to reduce costs and time tracking these.
- Began tracking IERs on DAF integrated schedule provided by MSTS and NCERC. Initiated IE telecons monthly to better track IERs to completion
- All BCRs for FY18 have been processed by CEdT Manager and a final IER status report was sent to the NCSP manager in December.
- The NCSP manager and execution manager made changes to the management team (Thomas Miller, CEdT Manager)
- Main and IE 5-year plan completed, published, and uploaded to the NCSP website.
- Participated in CSSG telecons and assisted with CSSG tasks as necessary.
- Completed FY17 accomplishments and uploaded to the NCSP website
- Started planning for TPR and Mission and Vision meetings scheduled for the week of March 26, 2018.
- Thomas Miller began as C_EdT Manager; Thomas works for Bowen in the ORNL Nuclear Data and Criticality Safety Group.
- Scott organized the “Recent Nuclear Criticality Safety Program Technical

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype), TS11 (CEdT Manage Support) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2018
	Accomplishments" session at the 2017 Washington DC Winter ANS meeting. Bowen chaired the session on behalf of the NCSP Manager. • and Bowen conducted the NCSP Technical Accomplishments **NCSP TS7 Succession Planning** • New ORNL Post Doc (Christopher Chapman) and new ORNL staff member (Andrew Holcomb) working on Nuclear Data (SAMMY/AMPX) tasks with the nuclear data team leader and staff. • ORNL junior R&D staff working with Luiz Leal on NCSP ND evaluation work. **NCSP TS8 NCSP MGT Tool** • Work on an initial prototype of a new NCSP Program Management Tool began in FY17Q3. Prototype system planning for incorporating the IER process in the NNSA G2 accounting system initiated in FY18Q1 for the IER process. Further work is pending for the NCSP 5YP project management tools. Metrics capability will not be part of the prototype. Scope of the project is in development.

NCSP QUARTERLY PROGRESS REPORT (FY 2018 Q1)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype), TS11 (CEdT Manage Support) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2018 **Page 3 of 3**

MILESTONES	Status	ISSUES/RESOLUTIONS
1. Manage C_EdT process and coordinate execution of planned IERs each FY. (TS2 All QTRs)		#7 – the prototype NCSP program management tool is delayed. A new way of tracking IERs in the NNSA G2 financial system are being investigated and initiated. The NCSP manager is considering needed options to support NCSP Management Team efforts moving forward.
2. Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. (TS2 All QTRs)		
3. Provide the NCSP manager with a summary of NCSP IE task TS11 as described in the task description. (TS11 All QTRs)		
4. Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY. (TS2 Q4)		
5. Publish final Five-Year Plan. (TS2 Q4)		
6. Provide NCSP Manager annual report of succession planning efforts. (TS7 Q4)		
7. Provide NCSP Manager a status report of progress on the development of a program management tool. (TS8 Q4)		

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

ORNL/SPR-2018/2

Reactor and Nuclear Systems Division

ORNL NCSP Technical Support Efforts in FY-2017

Douglas G. Bowen

Date Published: January 2018

Prepared for the
National Nuclear Security Administration
Nuclear Criticality Safety Program

Prepared by
OAK RIDGE NATIONAL LABORATORY
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DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

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1 INTRODUCTION

This document describes work performed by Oak Ridge National Laboratory (ORNL) under the United States Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP) 5-year plan (FY17-22). The FY17 5-year plan milestones include several Technical Support (TS) work tasks for ORNL that have specific reporting requirements, either quarterly or annually. The following list defines the three NCSP ORNL TS work tasks and reporting requirements for FY17.

- **NCSP TS2** – This is an ongoing approved task for ORNL to support the DOE NCSP Management in the program management and execution of the NCSP. ORNL is the Lead Laboratory for the NCSP infrastructure being responsible for the annual updates for the 5-year plan and the annual activities of the NCSP in supporting the NNSA Planning, Programming, Budgeting, and Evaluation (PPBE) cycle at the direction and supervision of the NCSP manager. Progress for this work task is summarized quarterly as part of the NCSP quarterly reporting process. A high-level summary is provided in this document and quarterly reports are provided as an appendix. Total funding: $576K.
    - **Milestones**:
        - **All Quarters**
            - Manage C_EdT process and coordinate execution of planned IERs each FY.
            - Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team.
        - **Quarter 4**
            - Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY.
            - Publish final Five-Year Plan.
- **NCSP TS7** – In accordance with the ten-year Mission and Vision, the NCSP has identified the need to develop and implement succession plans for key staff expert capabilities to support continued execution of the NCSP Mission. There is a need to maintain expertise in the nuclear data evaluation capabilities that currently exist at ORNL. The work associated with this task is to address key nuclear data evaluator succession planning needs for the NCSP. As part of this task, a post-doctoral staff member will work with an ORNL nuclear data evaluation specialist to complete NCSP nuclear data evaluation work tasks thereby training the next generation of nuclear data experts to perform neutron resonance analyses for the NCSP. Total funding: $120K.
    - **Milestone:**
        - **Quarter 4**
            - Provide NCSP Manager annual report of succession planning efforts.
- **NCSP TS8** – This is a new task to develop a program management tool that will improve the overall efficiency of managing the NCSP. Specifically, the tool will streamline the tasks to develop the NCSP Five Year Plan as well as manage and track the annual site work tasks. As a longer-term objective, an additional out year task will be to develop a NCSP management tool to streamline management and tracking of NCSP IE tasks and machine schedule availability at NCERC. Also, the NCSP program management tools will be developed to interface with the NNSA G2 system. The G2 system is developed and maintained by the ORNL Nonproliferation Systems Group (NSG) at ORNL. As a result, the ORNL/NSG will utilize previously-developed

program management tools, where possible, to expedite the development and implementation of the program management tools needed to support the management and execution of the NCSP. Total funding: $96K.

- **Milestone:**
  - **Quarter 4**
    - Develop initial prototype of NCSP Program Management Tool.

This document describes progress made on the ORNL NCSP TS tasks for FY17.

1.1 ORNL TASK MANAGER

Mike Dunn left ORNL abruptly, on February 15, 2017. Doug Bowen assumed all responsibilities as NCSP Program Execution and as ORNL Task Manager for all NCSP-sponsored work at ORNL on February 16, 2017 (Appendix A). As a result, the NCSP organization chart was updated to reflect these changes (Appendix A). The NCSP-funded work at ORNL falls into the following work categories (analytical methods [AM], integral experiments [IE], nuclear data [ND], training and education [TE] and technical support [TS]). The following table summarizes the NCSP work performed in FY17 and Appendix B provides the quarterly reports for FY2017 that document progress made on these tasks for FY2017.

ORNL NCSP Tasks in FY2017

NCSP Element	Effort	ORNL Personnel Tasked
AM	AM1 – RSICC Support	Tim Valentine and RSICC Staff
	AM2 – SCALE/KENO/TSUNAMI support	Brad Rearden, Manager, SCALE Code System Will Wieselquist, Deputy Manager, SCALE code system
	AM3 – AMPX nuclear data processing code modernization	Doro Wiarda, Nuclear Data and Criticality Safety R&D Staff Member
	AM6 – Update ORNL SlideRule in collaboration with LLNL and IRSN	Thomas Miller, Nuclear Data and Criticality Safety R&D Staff Member
IP&D	None	Not applicable
IE	IE1 – IER 450	Preliminary and final design funded by DOE-NE and work performed by ORNL
	IE1 – IER 441 – CED-1, 2	Justin Clarity for IER 441
	IE1 – IER 304 – CED-1	Thomas Miller for IER 304
	IE1 – IER 171, 173, & 175	These tasks were listed in the plan by mistake – not funded tasks
ND	ND1 – Nuclear data measurement and evaluation activities	Klaus Guber, Vlad Sobes, Marco Pigni, Andrew Holcomb
	ND4 – Thermal neutron scattering tasks in collaboration with RPI	Chris Chapman, Goran Arbanas
	ND6 – SAMMY modernization task	Goran Arbanas, Marco Pigni, Andrew Holcomb
TE	TE1 – Coordination of the NCSP NCS training and education program (this task also includes instructor and project management support)	Doug Bowen, Jeff Chapman, B.J. Marshall, Lori Scott
	TE5 – Collaborate with LANL on a 1-day introductory S/U training session	Doug Bowen, B.J. Marshall, Chris Perfetti
TS	NCSP TS2 – NCSP Program Management and Execution	Michael Dunn (10/16 to 2/17), Doug Bowen, Lori Scott, Jamie Sweers (10/16 to 9/17 – intermittent)
	NCSP TS7 – Succession planning	Doug Bowen, Goran Arbanas, Klaus Guber, Andrew Holcomb, Vlad Sobes
	NCSP TS8 – Development of an NCSP program management tool	Doug Bowen, Angela Chambers

2 NCSP PROGRAM EXECUTION (NCSP TS2)

Oak Ridge National Laboratory (ORNL) provides ongoing support for program management and execution of the NCSP to the DOE NCSP Manager, currently Dr. Angela Chambers, NA-511. ORNL is the Lead Laboratory for the NCSP infrastructure being responsible for the annual updates for the 5-year plan and the annual activities of the NCSP in supporting the NNSA PPBE cycle at the direction and supervision of the NCSP manager. In February 2017, Michael Dunn (Dunn), the previous NCSP execution manager left ORNL suddenly and the NCSP Manager assigned Doug Bowen the position of NCSP execution manager (Appendix A). A current NCSP organizational chart is also provided in Appendix A.

In FY2017, Doug Bowen (Bowen) currently provided execution manager support for the program with administrative support from Lori Scott (Scott) (Leidos, LLC, subcontractor). Dr. Chambers directed ORNL add an ORNL staff member to provide dedicated C_EdT support for increased focus on the management of NCSP integral experiment tasks. By the end of FY2017, Bowen had assigned Thomas Miller (Miller) as C_EdT Manager for the NCSP. Bowen had supported the NCSP as C_EdT Manager since 2013. Dr. Chambers has provided additional funding in FY18 toward the goal of improving the completion of IER milestones. In FY2017, the NCSP integral experiment 5-year plan includes 57 funded experiments (Appendix C). Only 4 experiments were completed by in FY2017 – all by LLNL. Of these 57 experiments, there were a total of 84 funded tasks in the NCSP and 24 were completed (7 by LANL, 14 by LLNL, 1 by ORNL, and 2 by SNL). Clearly, more effort is required by all sites, task managers, and NCSP management to ensure a better completion rate is achieved in FY18 and beyond.

For the other NCSP technical elements, Bowen provided coordination and instructor support for the NCSP training and education 1-week and 2-week hands-on courses, and B.J. Marshall and Jeff Chapman provided instructor support in FY17. Scott provided support for the NCSP website and other Information Preservation & Dissemination tasks, numerous administrative tasks, e.g., planning calendar, accomplishments, compilation of NCSP quarterly reports, development of main 5-year planning documents, and serving as the point of contact for the lecture portion of the 2-week hands-on criticality safety courses. Bowen also manages contracts for several CSSG members (Jerry Hicks, Dr. Mikey Brady-Rapp, and Fitz Trumble) through a subcontract with CS Engineering. Other NCSP resources (Tom McLaughlin, Calvin Hopper, and Mike Westfall) are also available via CS Engineering, as required. The management of these contracts requires a significant amount of administrative burden that was supported via NCSP TS2 funds. For example, a major contract rebid was accomplished in FY2017 to ensure contractor support could be provided to the NCSP via ORNL subcontracts.

Bowen and Scott worked together to develop, review, and publish both the main and integral experiment portions of the 5-year plan ahead of schedule. Numerous improvements were made to simplify the process in FY18 and beyond. The NCSP budget planning process typically takes a total of 7 months to complete and requires significant and consistent input from the NCSP Manager and NCSP task managers.

Dr. Chambers and Bowen participated in the NA-50 Programming Meetings in March 2017 at DOE Headquarters in Germantown, Md., to help prepare for the annual NNSA budget process.

The TS2 milestones listed in Section 1 were completed and discussed in the ORNL NCSP quarterly reports (Appendix B).

- **All Quarters**
    - Manage C_EdT process and coordinate execution of planned IERs each FY. ***This task is managed on an on-going basis. More communication with IE task managers (LANL, NNSS, LLNL, ORNL and SNL) was conducted this year. Bowen has concluded and recommended to the NCSP manager that too many tasks were accepted as priorities and funded in FY17. Fewer were accepted for FY18. Also, the KRUSTY experiments (IER 299) caused some disruption with respect to available resources for LANL IE support in FY17. Bowen set up a meeting with IE task managers and the NCSP manager on April 6, 2017 at SNL to focus on individual IE milestones. This effort helped generate a better process to track IERs to completion and to manage Baseline Change Requests. In FY18, this process is being further developed and improved and monthly IE telecons will be performed to more closely track IERs and LANL/LLNL collaborations to ensure milestones are completed in FY18.***
    - Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization effort by the NCSP Management Team. ***Scott and Bowen have archived the FY17 final task prioritization spreadsheets used to develop the Main and IE 5-year plans for FY18-22.***
- **Quarter 4**
    - Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY. ***Bowen and Scott both organized and participated in the Q4 Budget Execution Meeting held at the National Atomic Testing Museum in Las Vegas, NV, in July 2017. The NCSP Manager and NCSP task managers, in addition to international collaborators were present at the meeting. Bowen held both a Main 5-year Plan Task Manager planning session and an IER prioritization session to help finalize the 5-year plan documentation.***
    - Publish final Five-Year Plan. ***The main 5-year plan was published on September 29, 2017. The IE 5-year plan was published on November 1, 2017, after extensive re-reviews by IE task managers.***

3 SUCCESSION PLANNING (NCSP TS7)

Most succession planning funds in FY2017 were devoted to the development of ND staff because of the departure of Dr. Luiz Leal who left ORNL for IRSN in 2015. Further, Andrew Holcomb (Holcomb) and Chris Chapman (Chapman) were added to the NDCS group at ORNL following the completion of ND-related work funded by the NCSP. The NDCS staff have been working on modernization efforts, funded by TS7 funds, primarily with the SAMMY R-matrix code and the AMPX cross section development code. The following discussion provides details about specific efforts over the past few years, three graduate student summer interns (Jinghua Feng, Chapman[1], and Amanda Youmans), one postdoctoral researcher (Andrew Holcomb[2]), and two research staff members (Vladimir Sobes[3] [Sobes] and Marco Pigni [Pigni]) were introduced to the SAMMY code by Goran Arbanas and Dorothea Wiarda (Wiarda).

During the summer of 2017, a Nuclear Engineering Science Laboratory Synthesis (NESLS) summer intern, Jinghua Feng, prototyped a generalized least squares (GLS) implementation of the Fit API using the cpp-array interface to the BLAS library. Feng is a PhD graduate student of Prof. Emily (Li) Liu in the Nuclear Engineering Program at the Rensselaer Polytechnic Institute, Troy, NY. He also prototyped a novel Bayesian generalized data Monte Carlo implementation of the Fit API during his stay at ORNL. Feng's planned contributions to the SAMMY modernization effort may lead to a PhD thesis project that would train him for long-term development of nuclear data evaluation methods in the modernized SAMMY framework.

ORNL postdoctoral research associate, Holcomb, translated the prototype GLS method implemented by Feng to conform to the Fit API of the modernized SAMMY framework, thus producing an important backward-compatible parameter optimization method. This and any other parameter optimization method that implements Fit API could be used by all other modules of SCALE and AMPX.

ORNL research staff members who contributed to the SAMMY 8.1 release are Sobes and Wiarda. Sobes has contributed the SAMINT module that fine tunes mean values of R-matrix resonance parameters to achieve a better agreement between integral benchmark simulations and measurements, and he has created new SAMINT test cases. Wiarda has introduced the modern SQA of SCALE and AMPX to SAMMY, and she has also introduced robust methods for a piecemeal replacement of select legacy FORTRAN modules in SAMMY by their corresponding C++ API–based modernized modules, thus ensuring that legacy SAMMY results are reproduced by the modernized SAMMY at each step of the modernization. Summer intern Amanda Youmans has contributed high-fidelity liquid-scintillator and lithium glass detector resolution functions for improved data evaluations.

Chapman developed a thermal neutron scattering kernel evaluation capability to be included in the modernized version of SAMMY to enable first-time simultaneous fitting of R-matrix resonance parameters and thermal neutron scattering libraries. This will result in improved consistency and covariance data between the two corresponding energy ranges. Thermal neutron scattering data were measured by the RPI collaborators at ORNL's Spallation Neutron Source.

Sobes prepared a hands-on R-matrix course for nuclear data evaluators. The course was recently conducted at RPI and the Massachusetts Institute of Technology (MIT) to educate the new generation of nuclear engineers about the vital importance of nuclear data.

This document provides the annual report of the use of NCSP TS7 funds for succession planning efforts. These funds are crucial to support the mentoring and development of new ND evaluators and staff that can help with AMPX and SAMMY modernization efforts, as well as, to deliver new ND evaluations.

1 Chapman received his PhD from Georgia Institute of Technology for his work developing the thermal neutron scattering framework and joined the Nuclear Data & Criticality Safety Group as a postdoctoral research associate.
2 Holcomb joined the Nuclear Data & Criticality Safety Group as a full-time research staff member.
3 Sobes was converted from a post-doc researcher to a staff member in the NDCS group in 2015. In 2017, Sobes continued to collaborate with Luiz Leal (IRSN) as a succession planning task.

There is a significant need to develop backup capability for our single ND experimenter who performs the actual ND differential measurements.

4 PROGAM MANAGEMENT TOOL DEVELOPMENT (NCSP TS8)

In FY2016, the NCSP Manager tasked ORNL with the development of a project management tool to help develop and track NCSP milestones each fiscal year. Funding for this task was initiated in FY2017 for the sake of developing a prototype project management tool for the NCSP. Discussions with the ORNL G2 NNSA financial system staff were conducted with Bowen and the NCSP Manager in August 2017. After these discussions, the NCSP Manager was not sure how to proceed with utilizing this system for the NCSP and chose not to devote these funds for the project management system prototype. With NCSP Manager approval, the $96k in NCSP funds for NCSP TS8 were directed to ND measurement and evaluation work (ORNL ND1) instead. The future of this task is currently pending further contemplation and discussion amongst the NCSP Management team staff in FY18.

Appendix A NCSP Execution Management Information

Wednesday, December 27, 2017 at 1:15:17 PM Eastern Standard Time

Subject: FW: NCSP support
Date: Thursday, February 16, 2017 at 6:49:01 PM Eastern Standard Time
From: Chambers, Angela (ALBQ)
To: Lori Scott
CC: Bowen, Douglas G., Scott, Lori (CONTR), Sykes, Carl

Lori,

Could you please distribute the following email to the task managers, CSSG, CSCT, and the NDAG chair?

All,

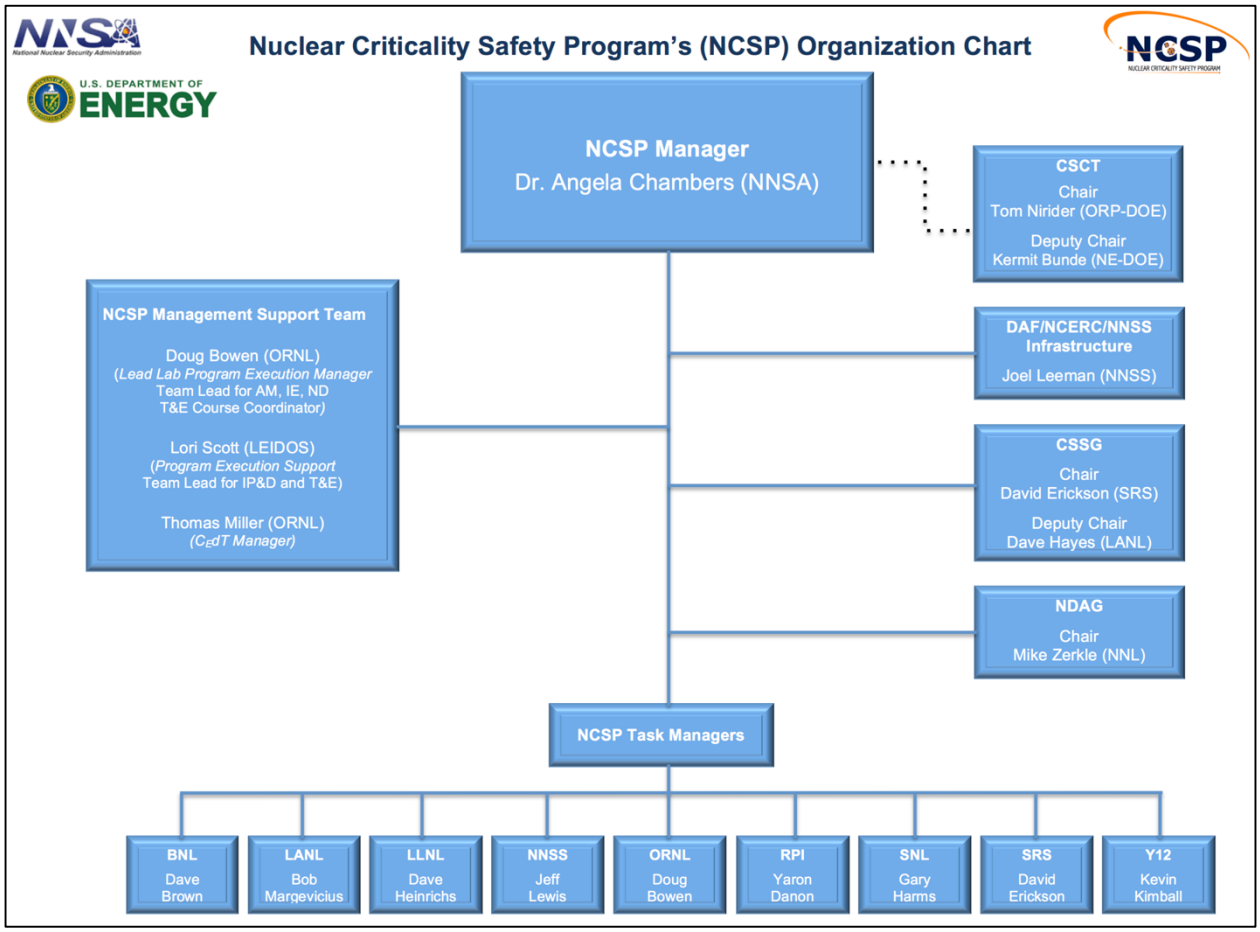
After successfully leading the NCSP Management Team for a number of years, Mike Dunn is moving on to new opportunities. Mike has been an invaluable resource to the NCS community in general and the NCSP, specifically. Doug Bowen is now the lead program execution manager for the NCSP Management Team. Doug has been a part of Mike's succession planning for a number of years and is ready to step into the role immediately. For the interim, Doug will also continue to coordinate the T&E courses and serve as CeDT Manager.

Looking forward to seeing you all at the TPR is DC in March.

Respectfully,
Angela

Page 1 of 1

Email from Dr. Chambers to the NCSP Task Managers, CSSG, CSCT, and NDAG About NCSP Management Changes (February 16, 2017)



Current NCSP Organization Chart (December 2017)

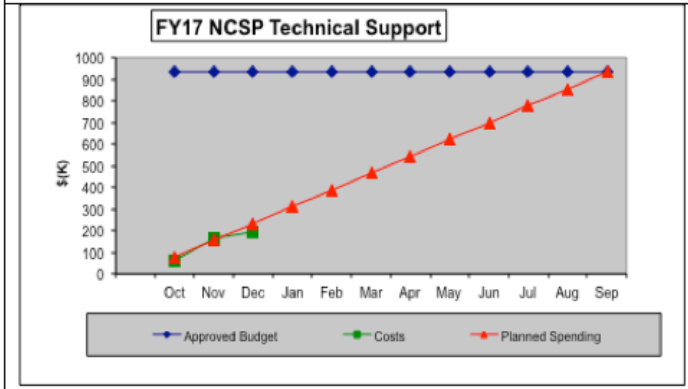
Appendix B ORNL TS Quarterly Reports

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q1)

NCSP Element and Subtask: TS2, 7 (NCSP Technical Support)
M&O Contractor Name: ORNL
Point of Contact Name: Michael Dunn
Point of Contact Phone: (865) 574-5260

Reference: DP0902000/ORNL
Date of Report: January 27, 2017
Page 1 of 2

BUDGET



1. **Carryover into FY 2017** = $69K
2. **Approved FY 2017 Budget** = $933K (includes carryover)
3. **Actual spending through the end of this quarter in FY 2017**= $193K
4. **Projected carryover in FY 2017** = $0K

ACCOMPLISHMENTS

- **NCSP TS2 Program MGT and Execution of the NCSP**
  - Prepare and maintain elements of NCSP Plan and associated activities:
    - Monitor Five-Year Plan progress,
    - Review/revise task list, and
    - Schedule/participate in meetings and teleconferences.
    - Manage and provide oversight/coordinate efforts for the NCSP Information, Preservation, and Dissemination task element.
    - Manage and provide oversight/coordinate efforts for the NCSP Training and Education Program task element.
    - Cross-train for current and succession planning.
  - Participated in several NCSP management team and other NCSP-related meetings, as required by the NCSP Manager.
  - Monitored efforts for the NCSP International Collaborations with IRSN and AWE.
  - Participated in an MS Project course in Dec. 7-8, 2016 in Knoxville, TN.
  - Coordinated and executed ANS Winter Meeting NCSP session Best Papers. The NCSP MGT team attended the ANS Winter Meeting in Las Vegas, NV, Nov. 5-10, 2016.
  - Completed and published IE FY17-21 Five-Year Plan.
  - Prepared Q4 QPRs into a single bookmarked PDF file for use in QPR. Conducted Q4 telecon.
  - The NCSP MGT team worked on designing and developing a new NCSP Quarterly Newsletter—Q1 Newsletter published Dec. 30, 2016.
  - Developed new NCSP Organization Chart to reflect Jerry McKamy's departure and Angela Chambers as the new NCSP Manager.
  - Initiated efforts to organize and solicit venue for the FY17 annual Budget Execution Meeting.
- **AM and ND:**
  - Organized and conducted AM Working Group meeting on December 10, 2016 at the ANS Meeting in Las Vegas, NV
  - Participated in NR/NCSP program review of the RPI accelerator modernization on December 14, 2016—met with NR staff about continued collaboration and resolution of DOE/SC sample lease issues
- **IE:**
  - Managed and provided oversight/coordination of efforts for the NCSP IE task

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q1)

NCSP Element and Subtask: TS2, 7 (NCSP Technical Support) **M&O Contractor Name:** ORNL **Point of Contact Name:** Michael Dunn **Point of Contact Phone:** (865) 574-5260	**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2017 **Page 1 of 2**
	element. ○ Processed IER approvals and BCRs for NCSP Manager. ○ C_EDT Coordinator and deputy C_EDT lead developed process to track NCSP-funded IERs, including how to work with the BCR process. ○ Continued ongoing communication and collection efforts for foreign trip and WFO reports from task managers. ○ NCSP management team attended the KiloPower Reactor Using Stirling Technology (KRUSTY) meeting in Washington DC, November 1-3, 2016. • **IP&D:** ○ Worked with NCSP Website manager to develop a searchable database for easy retrieval of NCSP Products and WFO products. ○ Continued work on revised NCSP website materials. IP&D Lead initiated annual NCSP website content review in Nov. ○ Worked on compiling and organizing LANL Quarterly reports for fiscal years 2013-2016 for an NCERC audit being performed by the DOE Inspector General's office. C_EDT Coordinator interfaced directly with the Inspector General staff on questions about the NCSP, C_EDT process, and NCERC. ○ Continued ongoing communication and collection of foreign trip reports from task managers. • **T&E:** ○ Updated Student Information Booklets for the TEP manager courses on the NCSP website with updated logistical information. ○ Began execution on CSSG assessment report comment resolution plan (CSSG tasking 2016-01). ○ Continued development of an NCSP TEP course procedure. Plan to publish in FY17 Q1. ○ Preparations began for the Sandia Manager Course in Jan. 9-13, 2017, and the 2-week Hands-on Course in Jan. 30-Feb. 10, 2017.

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q1)

NCSP Element and Subtask: TS2, 7 (NCSP Technical Support) **M&O Contractor Name:** ORNL **Point of Contact Name:** Michael Dunn **Point of Contact Phone:** (865) 574-5260	**Reference:** DP0902000/ORNL **Date of Report:** January 27, 2017 **Page 2 of 2**

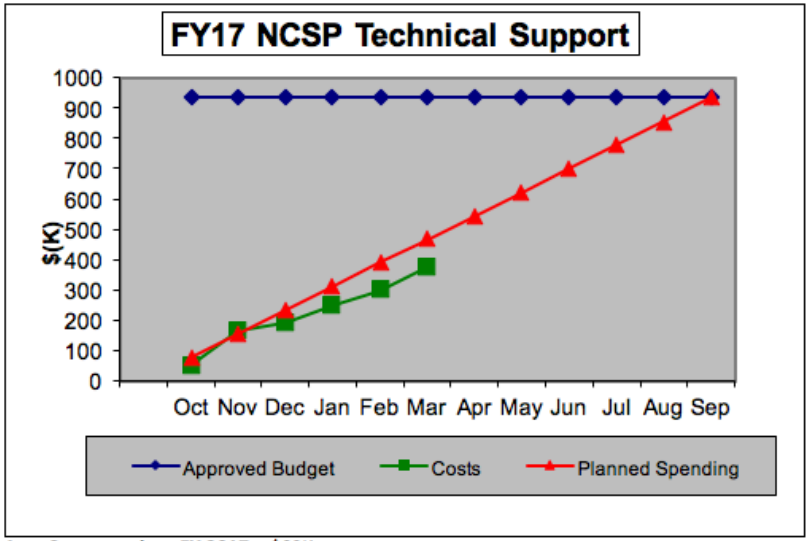
MILESTONES	Status	ISSUES/RESOLUTIONS
1. Manage C_EdT process and coordination execution of planned Integral Experiment Requests (IERs) each FY (TS2: All Qtrs).		
2. Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization efforts by the NCSP Management Team (TS2: All Qtrs).		
3. Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY (TS2: Q4).		
4. Publish final Five Year Plan (TS2: Q4).		
5. Provide NCSP Manager annual report of succession planning efforts (TS7:Q4).		
6. Develop initial prototype of NCSP Program Management Tool (TS8:Q4).		

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q2)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype)
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0902000/ORNL
Date of Report: May 1, 2017

BUDGET



1. **Carryover into FY 2017** = $69K
2. **Approved FY 2017 Budget** = $933K (includes carryover)
3. **Actual spending for 1st quarter FY 2017** = $193K
4. **Actual spending for 2nd quarter FY 2017** = $181K
5. **Projected carryover into FY 2018** = $0K

ACCOMPLISHMENTS

NCSP TS2 Program MGT and Execution of the NCSP

- Prepare and maintain elements of NCSP Plan and associated activities:
  - Monitor Five-Year Plan progress,
  - Review/revise task list, and
  - Schedule/participate in meetings and teleconferences.
  - Manage and provide oversight/coordinate efforts for the NCSP Information, Preservation, and Dissemination task element.
  - Manage and provide oversight/coordinate efforts for the NCSP Training and Education Program task element.
  - Cross-train for current and succession planning.
- D. Bowen hosted the NCSP Manager at Oak Ridge National Laboratory on March 30, 2017. D. Bowen and A. Chambers attended a KRUSTY status/budget meeting at Y12.
- Participated in several NCSP management team and other NCSP-related meetings, as required by the NCSP Manager.
- Monitored efforts for the NCSP International Collaborations with IRSN and AWE. D. Bowen attended collaboration meetings for the NCSP Manager March 14, 2017 at Forrestal for the DOE Office of Nuclear Energy and IRSN.
- Organized and conducted Technical Program Review meeting in Washington, DC, March 14-15, 2017. Selected best paper award winners for presentation at the ANS winter meeting. NCSP MGT team participated in the Analytical Methods Working Group and CEdT training meetings on Monday.
- Worked on collecting Five-Year Plan input from task managers.
- Prepared Q1 QPRs into a single bookmarked PDF file for use in QPR. Conducted Q1 telecon.
- The NCSP MGT team worked on designing and developing a new NCSP Quarterly Newsletter for client. NCSP FY17 Q1 Newsletter was published April 18, 2017.
- Developed a new NCSP Organization Chart to reflect Mike Dunn's departure.
- Arranged a venue for the FY17 annual Budget Execution Meeting (National Atomic Testing Museum, Las Vegas, NV).
- Prepared pre-decisional task list for CSSG review and discussion at TPR in March 2017. Prepared proposals from FY17 and FY18 to assist the CSSG with their efforts to prioritize the pre-decisional task list.
- Redefined the process for tracking non-NCSP funded tasks to reduce costs and time tracking these
- No work performed on tracking NCERC/DAF metrics this quarter

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q2)

NCSP Element and Subtask: TS2, 7 (NCSP Technical Support) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** May 1, 2017 **Page 2 of 4**
MILESTONES	**ISSUES/RESOLUTIONS**

	• **IE:**
	  • Managed and provided oversight/coordination of efforts for the NCSP IE task element.
	  • Processed IER approvals and BCRs for NCSP Manager.
	  • Prepared for an IER Meeting at Sandia National Laboratory on Apr. 6, 2017. Updated the status of all IERs in preparation for the meeting.
	  • Doug Bowen and Jamie Sweers worked a process to track NCSP-funded IERs, including how to work with the BCR process.
	  • Continued ongoing communication and collection efforts for foreign trip and WFO reports from task managers.
	  • NCSP management team attended the KiloPower Reactor Using Stirling Technology (KRUSTY) meeting in Washington DC, November 1-3, 2016. The NCSP MGT team participated in weekly KRUSTY telecons.
	• **IP&D:**
	  • Worked with NCSP Website manager to develop a searchable database for easy retrieval of NCSP Products and WFO products.
	  • Continued work on revised NCSP website materials. Lori Scott continued work on the annual NCSP website content review
	  • Continued ongoing communication and collection of foreign trip reports from task managers.
	• **T&E:**
	  • Updated Student Information Booklets for the TEP manager courses on the NCSP website with updated logistical information.
	  • Continued execution on CSSG assessment report comment resolution plan (CSSG tasking 2016-01). (% CSSG 2016-01 comments resolved: NFO –75%, NCERC–47%, Sandia–29%, Overall–60%)
	  • Continued work on the NCSP T&E Course Procedure based on lessons learned from the Jan/Feb MGR and Hands-on courses, respectively, to standardize course registration, course materials/changes, logistics, and execution—feedback from CSSG Tasking 2016-01 will be incorporated into draft procedure prior to issuing procedure. The T&EP coordinator will be working with Becka Hudson to find a DAF and NFO badging coordinator to assist with student paperwork for these portions of the 2-week hands-on course.
	  • Preparations began for the NCERC Manager Course in Jun. 19-23, 2017, and the 2-week Hands-on Course in Aug. 14-25, 2017.

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q2)

NCSP Element and Subtask: TS2, 7 (NCSP Technical Support) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** May 1, 2017 **Page 3 of 4**
MILESTONES	**ISSUES/RESOLUTIONS**
	NCSP TS7 Succession Planning • ORNL Post Doc working on Nuclear Data tasks with Doro Wiarda **NCSP TS8 NCSP MGT Tool** • No work performed to date due to funding issues at ORNL. Work on an initial prototype of a new NCSP Program Management Tool to begin in Q3.

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q2)

NCSP Element and Subtask: TS2, 7 (NCSP Technical Support) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** May 1, 2017 **Page 4 of 4**

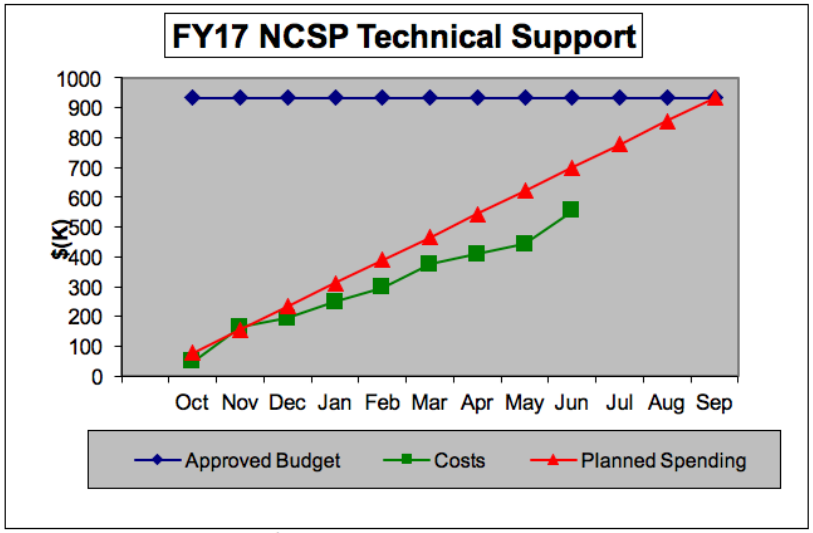
MILESTONES	Status	ISSUES/RESOLUTIONS
1. Manage CEdT process and coordination execution of planned Integral Experiment Requests (IERs) each FY (TS2: All Qtrs).		Issues with the KRUSTY critical experiment (schedule and cost) are driving significant delays in the IE 5-year plan milestones for FY17. The impact of these delays is being assessed will be discussed at an IER status meeting on April 6, 2017, at Sandia National Laboratory.
2. Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization efforts by the NCSP Management Team (TS2: All Qtrs).		
3. Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY (TS2: Q4).		
4. Publish final Five Year Plan (TS2: Q4).		
5. Provide NCSP Manager annual report of succession planning efforts (TS7: Q4).		
6. Develop initial prototype of NCSP Program Management Tool (TS8:Q4).		

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q3)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype)
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0902000/ORNL
Date of Report: July 17, 2017

BUDGET



1. **Carryover into FY 2017** = $69K
2. **Approved FY 2017 Budget** = $933K (includes carryover)
3. **Actual spending for 1st quarter FY 2017** = $193K
4. **Actual spending for 2nd quarter FY 2017** = $374K
5. **Actual spending for 3rd quarter FY 2017** = $555K
6. **Projected carryover into FY 2018** = $0K

ACCOMPLISHMENTS

NCSP TS2 Program MGT and Execution of the NCSP

- Prepare and maintain elements of NCSP Plan and associated activities:
  - Monitor Five-Year Plan progress,
  - Review/revise task list, and
  - Schedule/participate in meetings and teleconferences.
  - Manage and provide oversight/coordinate efforts for the NCSP Information, Preservation, and Dissemination task element.
  - Manage and provide oversight/coordinate efforts for the NCSP Training and Education Program task element.
  - Cross-train for current and succession planning.
- Participated in several NCSP management team and other NCSP-related meetings, as required by the NCSP Manager.
- Monitored efforts for the NCSP International Collaborations with IRSN and AWE. D. Bowen and Angela Chambers conducted a telecon with IRSN for 5YP planning efforts on June 7, 2017.
- Worked on collecting Five-Year Plan input from task managers.
- Prepared Q2 QPRs into a single bookmarked PDF file for use in QPR. Conducted Q2 telecon.
- NCSP FY17 Summer newsletter in progress.
- Continued planning efforts for the FY17 annual Budget Execution Meeting (National Atomic Testing Museum, Las Vegas, NV).
- Modified pre-decisional task list for Angela Chamber's review for Budget Execution Meeting.
- Redefined the process for tracking non-NCSP funded tasks to reduce costs and time tracking these.
- No work performed on tracking NCERC/DAF metrics this quarter. Doug Bowen and Lori Scott have discussed how to proceed with this NCSP Manager task.

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q3)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** July 17, 2017 **Page 2 of 3**
MILESTONES	**ISSUES/RESOLUTIONS**
	NCSP TS7 Succession Planning • ORNL Post Doc working on Nuclear Data tasks with Doro Wiarda • ORNL junior R&D staff working with Luiz Leal on ND evaluation work. **NCSP TS8 NCSP MGT Tool** • Work on an initial prototype of a new NCSP Program Management Tool began in Q3. Prototype system expected by end of Q4 for the NCSP 5YP project management tools. Metrics capability will not be part of the prototype.

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q3)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** May 1, 2017 **Page 3 of 3**

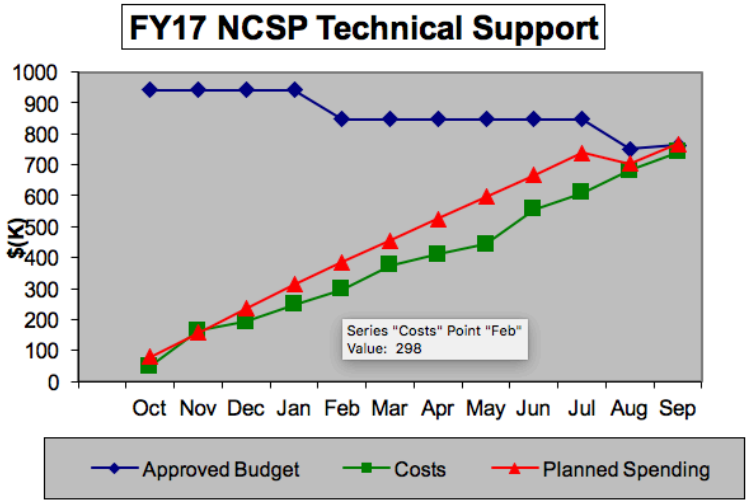
MILESTONES	Status	ISSUES/RESOLUTIONS
1. Manage C_EdT process and coordination execution of planned Integral Experiment Requests (IERs) each FY (TS2: All Qtrs).		Issues with the KRUSTY critical experiment (schedule and cost) are driving significant delays in the IE 5-year plan milestones for FY17. The impact of these delays is being assessed will be discussed at the NCSP budget execution meeting.
2. Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization efforts by the NCSP Management Team (TS2: All Qtrs).		
3. Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY (TS2: Q4).		
4. Publish final Five-Year Plan (TS2: Q4).		
5. Provide NCSP Manager annual report of succession planning efforts (TS7: Q4).		
6. Develop initial prototype of NCSP Program Management Tool (TS8:Q4).		

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q4)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype)
M&O Contractor Name: ORNL
Point of Contact Name: Doug Bowen
Point of Contact Phone: (865) 576-0315

Reference: DP0902000/ORNL
Date of Report: Oct. 17, 2017

BUDGET



1. **Carryover into FY 2017** = $69K
2. **Approved FY 2017 Budget** = $933K (includes carryover)
3. **Actual spending for 1st quarter FY 2017** = $193K
4. **Actual spending for 2nd quarter FY 2017** = $374K
5. **Actual spending for 3rd quarter FY 2017** = $555K
6. **Projected carryover into FY 2018** = $23K

ACCOMPLISHMENTS

NCSP TS2 Program MGT and Execution of the NCSP

- Prepare and maintain elements of NCSP Plan and associated activities:
- Monitor Five-Year Plan progress,
- Review/revise task list, and
- Schedule/participate in meetings and teleconferences.
- Manage and provide oversight/coordinate efforts for the NCSP Information, Preservation, and Dissemination task element.
- Manage and provide oversight/coordinate efforts for the NCSP Training and Education Program task element.
- Cross-train for current and succession planning.
- Participated in several NCSP management team and other NCSP-related meetings, as required by the NCSP Manager.
- Worked with NDAG Chair to schedule and conduct the Nuclear Data prioritization meeting held in late July 2017.
- Conducted a telecon with Tim Wynn (ORNL) and staff about replacing the current 5-year plan tools and implementing integral experiment metrics.
- Worked on collecting Five-Year Plan input from task managers.
- Prepared Q3 QPRs into a single bookmarked PDF file for use in QPR. Conducted Q3 telecon.
- Published NCSP FY17 Summer newsletter and fall newsletter is in progress.
- Conducted FY17 annual Budget Execution Meeting (National Atomic Testing Museum, Las Vegas, NV).
- Finalized FY18 task list following the Budget Execution Meeting.
- Redefined the process for tracking non-NCSP funded tasks to reduce costs and time tracking these.
- No work performed on tracking NCERC/DAF metrics this quarter. Doug Bowen and Lori Scott have discussed how to proceed with this NCSP Manager task.
- All BCRs for FY17 have been processed by CEdT Manager and a final IER status report was sent to the NCSP manager.
- The NCSP manager and execution manager made changes to the management team. Organization chart updated accordingly.
- NCSP management team attended and attended the NCSP topical meeting in Carlsbad, NM. The management team met as needed to conduct NCSP business.

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q4)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** Oct. 17, 2017 **Page 1 of 3**
	• Main 5-year plan completed and uploaded to the NCSP website. IE portion of the plan is nearing completion. • Participated in CSSG telecons. **NCSP TS7 Succession Planning** • ORNL Post Doc working on Nuclear Data tasks with Doro Wiarda • ORNL junior R&D staff working with Luiz Leal on ND evaluation work. **NCSP TS8 NCSP MGT Tool** • Work on an initial prototype of a new NCSP Program Management Tool began in Q3. Prototype system planning continued in Q4 for the NCSP 5YP project management tools. Metrics capability will not be part of the prototype. The NCSP manager is considering adding the IER database to the G2 system. Planning for this is in progress.

NCSP QUARTERLY PROGRESS REPORT (FY 2017 Q4)

NCSP Element and Subtask: TS2 (NCSP Technical Support), TS7 (Succession Planning), TS8 (NCSP MGT Tool Prototype) **M&O Contractor Name:** ORNL **Point of Contact Name:** Doug Bowen **Point of Contact Phone:** (865) 576-0315	**Reference:** DP0902000/ORNL **Date of Report:** Oct. 17, 2017 **Page 3 of 3**

MILESTONES	Status	ISSUES/RESOLUTIONS
1. Manage $C_E dT$ process and coordination execution of planned Integral Experiment Requests (IERs) each FY (TS2: All Qtrs).		Issues with the KRUSTY critical experiment (schedule and cost) are driving significant delays in the IE 5-year plan milestones for FY17. The impact of these delays is being assessed will be discussed at the NCSP budget execution meeting. #6 – the prototype NCSP program management tool has been delayed. The NCSP manager is considering this option and NCSP Management Team needs moving forward. The remaining budget at the end of Aug. 2017 was reprioritized to ORNL ND1 work because of this delay.
2. Maintain up-to-date spreadsheet of proposed tasks for NCSP Manager after the NCSP proposal review meeting and through the final task prioritization efforts by the NCSP Management Team (TS2: All Qtrs).		
3. Participate in Q4 Budget Execution Meeting and assist NCSP Manager in finalization of approved tasks for next FY (TS2: Q4).		
4. Publish final Five-Year Plan (TS2: Q4).		
5. Provide NCSP Manager annual report of succession planning efforts (TS7: Q4).		
6. Develop initial prototype of NCSP Program Management Tool (TS8:Q4).		

Appendix C FY2017 Integral Experiment Milestone Summary

FY17 NCSP IE 5-Year Plan – MILESTONE SUMMARY

Organization – Experiments

Organization	Total Number	Total Completed	Percent
NCSP	57	4	7.0%
LANL	23	0	0.0%
LLNL	23	4	17.4%
ORNL	3	0	0.0%
SNL	8	0	0.0%

Organization – Milestones

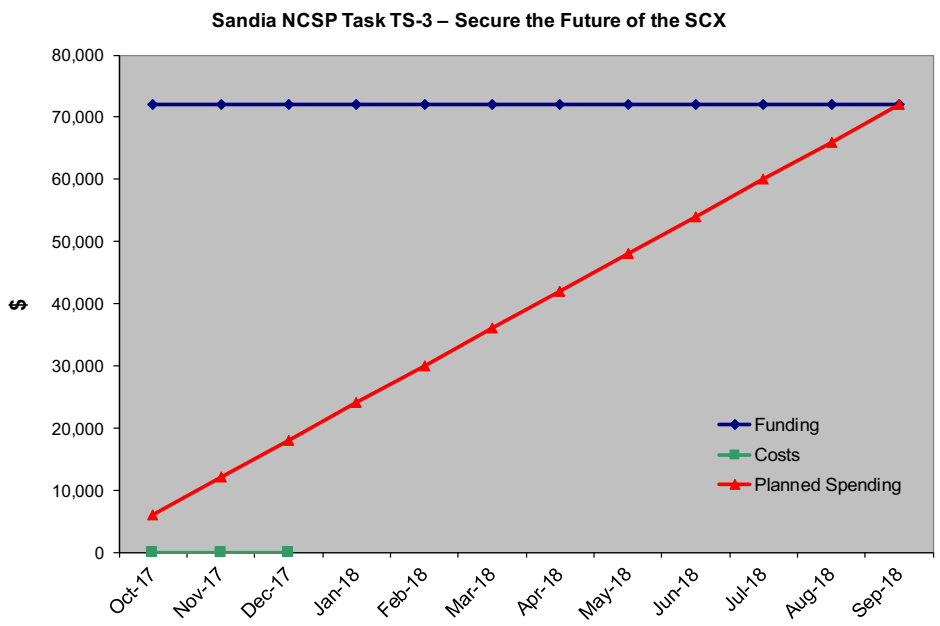
Organization		Total Number	Total Completed	Percent
NCSP		84	24	28.6%
Details	CED-1	15	6	40.0%
	CED-2	18	5	27.8%
	CED-3a	18	4	22.2%
	CED-3b	16	4	25.0%
	CED-4a	11	2	18.2%
	CED-4b	6	3	50.0%
LANL		32	7	21.9%
Details	CED-1	7	3	42.9%
	CED-2	9	3	33.3%
	CED-3a	8	1	12.5%
	CED-3b	5	0	0.0%
	CED-4a	1	0	0.0%
	CED-4b	2	0	0.0%
LLNL		36	14	38.9%
Details	CED-1	3	1	33.3%
	CED-2	6	2	33.3%
	CED-3a	8	2	25.0%
	CED-3b	9	4	44.4%
	CED-4a	8	2	25.0%
	CED-4b	2	3	150.0%
ORNL		3	1	33.3%
Details	CED-1	2	1	50.0%
	CED-2	1	0	0.0%
	CED-3a	0	0	–
	CED-3b	0	0	–
	CED-4a	0	0	–
	CED-4b	0	0	–
SNL		13	2	15.4%
Details	CED-1	3	1	33.3%
	CED-2	2	0	0.0%
	CED-3a	2	1	50.0%
	CED-3b	2	0	0.0%
	CED-4a	2	0	0.0%
	CED-4b	2	0	0.0%

NCSP Quarterly Progress Report (FY-2018 Q1)

NCSP Element: Sandia TS3 – Secure the Future of the SCX
M&O Contractor Name: Sandia National Laboratories (SNL)
Point of Contact Name: Gary A. Harms
Point of Contact Phone: (505)845-3244

Reference: B&R DP 0909010
Date of Report: December 31, 2017

BUDGET



1. Carryover from the Previous FY = $0
2. Approved Current FY Budget = $72,000
3. Costs at the End of the Quarter = $0
4. Carryover into the Next FY = $0

ACCOMPLISHMENTS

- We have a matrixed employee who is being trained as an experimenter.
- The new experimenter has been executing the IER-451 experiments.

MILESTONES

Develop critical experimentalists

ISSUES/PATH FORWARD

We have not charged to this task in the first quarter.

Green = On Schedule, Yellow = Behind Schedule, Red = Missed Milestone, Blue = Completed

2018-02-01

Summary of Recent Classes

F.B. Brown, M.E. Rising, J.L. Alwin
Monte Carlo Methods, Codes, & Applications Group (XCP-3), LANL

FY2018 – Q1 classes are highlighted in red.

Classes sponsored by DOE-NNSA-NCSP (LANL-AM1)

- **Sensitivity-Uncertainty Tools & Practices for NCS Validation**
  - Aug 7, 2017, ORNL, 15 participants
  - Aug 8, 2017, Y-12, 15 students
  - TBD, 2018, Savannah River,

  This is a joint effort between LANL & ORNL, covering background material and specific usage of MCNP6-Whisper and SCALE-KENO-TSUNAMI-TSURFER. D. Bowen coordinates scheduling at DOE sites.

- **Criticality Calculations with MCNP6**
  - Aug 14-18, 2017, LANL, 12 students
  - Feb 26 – Mar 2, 2018, LANL,
  - TBD, 2018, Y-12,
  - Aug 6-10, 2018, LANL,

  MCNP criticality class for NCS & reactor physics practitioners, with focus on best practices. Includes 1 day on NCS validation using MCNP6-Whisper.

  For classes at LANL, NCSP-sponsored students do not pay registration fees. For classes at other DOE sites, there are no registration fees.

- **Monte Carlo Techniques for Nuclear Systems**
  - Aug 25 – Dec 8, 2017, UNM, 18 students

  This is a 1-semester class for senior undergrads & graduate students at the University of New Mexico. Required for UNM graduation in Nuclear Engineering. Includes Monte Carlo theory & practical use of MCNP6. 2 of the students were part of the LANL NCS intern program. (This teaching is partially supported by NCSP, ASC, and other programs.)

- **Advanced Computational Methods for Monte Carlo Calculations**
  - Jan 17 – May 9, 2018, UNM, 8 students

  This is an advanced class covering details of transport theory, Monte Carlo, advanced computing methods, and code development. Material from this course is also used to teach LANL staff members. (This teaching is partially supported by NCSP, ASC, and other programs.

Other Classes (LANL-AM1)

- **Introduction to MCNP6**
  - Dec 4-8, 2017, LANL, 15 students
  - Dec 11-15, 2017, NCSU 30 students
  - Apr 2-6, 2018, LANL,
  - June 4-8, 2018, LANL,
  - Aug 13-17, 2018, LANL,
  - Dec 3-7, 2018, LANL,

  Standard introductory class, includes 1/2 day on criticality calculations. Classes at LANL are supported by student registration fees.

  The class at North Carolina State University (NCSU) included undergraduate & graduate students. This was the first off-site class in 10 years that was not held at a DOE site.

Class Name	Class Dates	Location	Attendees	Description
SCALE/TRITON Lattice Physics and Depletion	Oct 2 – Oct 6, 2017	Oak Ridge National Laboratory, Oak Ridge, TN	13 Attendees from 3 countries	SCALE supports a wide range of reactor physics analysis capabilities. SCALE reactor physics calculations couple neutron transport calculations with ORIGEN to simulate the time-dependent transmutation of various materials of interest. TRITON is SCALE's modular reactor physics sequence for a wide variety of system types. Attendees of this course will learn how to use TRITON for depletion analysis. The TRITON training material is centered around using the NEWT 2-D transport module for 2-D depletion analysis and briefly touches on 3-D depletion analysis. The course will instruct users on the use of KENO in place of NEWT for 3-D Monte Carlo-based depletion; however, KENO is not covered in depth within this course. Additional applications of TRITON are incorporated into the training, including the creation of ORIGEN libraries for rapid spent fuel characterization calculations, defining appropriate unit cell calculations of various reactor types for cross section processing, performing restart calculations, and performing uncertainty analysis of reactor physics calculations using Sampler.
SCALE/ORIGEN Standalone Fuel Depletion, Activation, and Source Term Analysis	Oct 9 – Oct 13, 2017	Oak Ridge National Laboratory, Oak Ridge, TN	12 attendees from 5 countries	This is a hands-on class that covers the use of ORIGEN for isotopic depletion, decay, decay heat, and radiation source-terms calculations. The course features the use of the Fulcrum consolidated SCALE graphical interface and Fulcrum plotting capabilities for displaying nuclear data and results. The class includes solving activation, spent fuel, and nuclear safeguards and security analyses. This class provides an introduction to the ORIGAMI tool for convenient characterization of spent nuclear fuel with radially and axially varying burnup. Advanced applications including simulation of chemical processing, continuous feed and removal are also covered.

SCALE Criticality Safety and Radiation Shielding Course	Oct 16 – Oct 20, 2017	Oak Ridge National Laboratory, Oak Ridge, TN	11 attendees from 3 countries	This course provides instruction on the use of the KENO-VI Monte Carlo code for criticality safety calculations and the MAVRIC (Monaco with Automated Variance Reduction using Importance Calculations) shielding sequence with 3-D automated variance reduction for deep-penetration problems. KENO-VI is a 3D eigenvalue Monte Carlo code for criticality safety and Monaco is a 3D fixed-source Monte Carlo code for shielding analysis. Both codes use the SCALE Standard Composition Library and the SCALE Generalized Geometry Package (SGGP), which allows for versatile modeling of complex geometries and provides convenient, efficient methods for modeling repeated and nested geometry configurations such as lattices. The MAVRIC sequence is based on the CADIS (Consistent Adjoint Driven Importance Sampling) methodology. For a given tally in a Monte Carlo calculation that the users wants to optimize, the CADIS method uses the result of an adjoint calculation from the Denovo 3D deterministic code to create both an importance map for weight windows and a biased source distribution. MAVRIC is completely automated in that from a single user input, it creates the cross sections (forward and adjoint), computes the adjoint fluxes, creates the importance map and biased source, and then executes Monaco. An extension to the CADIS method using both forward and adjoint discrete ordinates calculations (FW-CADIS) is included in MAVRIC so that multiple point tallies or mesh tallies over large areas can be optimized (calculated with roughly the same relative uncertainty). Both KENO and Monaco use ENDF/B-VII.0 or ENDF/B-VII.1 cross-section data distributed with SCALE to perform continuous energy (CE) or multigroup (MG) calculations. Both codes can also be used with the Fulcrum consolidated SCALE user interface and KENO3D for interactive model setup, computation, output review, and 3-D visualization. Instruction is also provided on the SCALE material input and resonance self-shielding capabilities and the data visualization capabilities within Fulcrum for visualizing fluxes, reaction rates, and cross-section data as well as mesh tallies. KENO-VI and MAVRIC can be applied together to perform an integrated criticality accident alarm system (CAAS) analysis.

SCALE Sensitivity and Uncertainty Analysis for Criticality Safety Assessment and Validation Course	Oct 23 - Oct 27, 2017	Oak Ridge National Laboratory, Oak Ridge, TN	5 attendees from 2 countries	Sensitivity and uncertainty analysis methods provide advanced techniques for criticality safety validation including the identification of appropriate experiments, detailed quantification of bias and bias uncertainty, identification of gaps in available experiments, and the design of new experiments. The Sampler sequence within SCALE provides a flexible tool for quantifying uncertainties due to manufacturing tolerances as well as composition and dimensional uncertainties in criticality safety assessments. This 5-day training class provides a foundation on sensitivity and uncertainty analysis and applies these methods to criticality safety validation applications, as well as instruction on the use of Sampler for uncertainty quantification. Topics covered include: • The TSUNAMI sensitivity and uncertainty analysis techniques for determining the sensitivity of the k-eff eigenvalue to cross section uncertainties using both multigroup and continuous-energy physics. • SCALE's comprehensive cross section covariance data library, which is applied to these sensitivity coefficients to estimate the data-induced uncertainty in k-eff. • The TSUNAMI-IP code, which determines the correlation between benchmark and application systems in terms of their shared sources of data-induced uncertainty. • The USLSTATS trending analysis tool, which uses similarity coefficients from TSUNAMI-IP (among other parameters) to estimate the computational bias and bias uncertainty for design and licensing applications. • The TSURFER data adjustment tool, which uses generalized linear least squares to adjust nuclear data parameters to minimize discrepancies between computed predictions and the results of integral experiments; these adjustments can then be used to estimate bias and bias uncertainty in design and licensing applications. • The SAMPLER code for uncertainty assessment, which randomly samples nuclear data and/or system compositions and dimensions to quantify the uncertainty in system k-eff.
KENO-VI and ORIGEN	Nov 13 - Nov 15, 2017	Air Force Institute of Technology, Wright-Patterson AFB	7 attendees	Hands-on SCALE Training on KENO-VI Monte Carlo criticality and ORIGEN depletion/decay codes was provided to seven first-year graduate students in the Department of Engineering Physics (Nuclear Engineering Program) at the Air Force Institute of Technology, Wright-Patterson Air Force Base, OH. Students will use SCALE for small class projects and will have the opportunity to use SCALE as part of their MS thesis work.

SCALE/ORIGEN for Nuclear Nonproliferation and Safeguards Applications–Tutorial	11/2/17	ANS Winter Meeting, Washington DC	10 attendees	The aim of this tutorial is to provide an overview of ORIGEN's capabilities, with a focus on those that directly support safeguards and nonproliferation applications. Hands-on examples will be included, such as estimation of uranium and plutonium in spent fuel for material reporting and calculation of neutron and gamma sources to support spent fuel verification. No prior experience with SCALE is required.
SCALE/ORIGEN for Shielding Source Term Generation–Tutorial	11/2/17	ANS Winter Meeting, Washington DC	10 attendees	This tutorial will focus on generating source terms for arbitrary materials. Hands-on examples will be included on generating neutron and photon sources for irradiated fuel and activated structural components and feeding ORIGEN neutron and photon sources into a MAVRIC shielding calculation.